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Cirolanidae (Crustacea: Isopoda: Flabellifera) of the Tropical Eastern Pacific

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Dedicated to the memory of J. Laurens Barnard

ABSTRACT.—The cirolanid isopods of the tropical eastern Pacific (central western Baja California, Mexico, to the Peru–Ecuador border) encompass 18 species in 8 genera, including 7 species newly described here: *Anopsilana aleci*, *Cirolana namelessensis*, *Cirolana nielbrucei*, *Conilera bullisi*, *Metacirolana calypso*, *Natatolana carlenae*, and *Oncilorpheus jerrybarnardi*. Complete species lists are provided for all genera treated. The tropical eastern Pacific genera and species are described and keyed, and their ecology and distribution are discussed. The second known species of *Oncilorpheus* and third known species of *Conilera* are described, both representing the first records of the genera from the Pacific Ocean. Fifteen of these 18 species (83%) occur primarily in the tropical eastern Pacific zoogeographic region. Four species (22%) are amphi-American in distribution. One species is endemic to the Gulf of California (*Cirolana nielbrucei* n. sp.), and one is endemic to the Galapagos Islands (*Metacirolana calypso* n. sp.). Compared to that of the tropical Caribbean and tropical Indo–west Pacific, the cirolanid fauna of the tropical eastern Pacific is relatively depauperate.

INTRODUCTION

This paper is one in a series of regional monographs and shorter papers describing the shallow-water marine isopods of the tropical eastern Pacific [the "Panamic region" of Ekman (1953), the "eastern Pacific zoogeographic region" of Brusca and Wallerstein (1979a)]—central western Baja California and the Gulf of California (Mexico) to the Gulf of Guayaquil, Ecuador. The family Idoteidae was treated by Brusca (1983, 1984), Brusca and Wallerstein (1977, 1979b), and Wallerstein and Brusca (1982). The family Cymothoidae was treated by Brusca (1977, 1978a, 1978b, 1981), Brusca and Gilligan (1983), and Thun and Brusca (1980). The families Corallanidae and Excorallanidae were covered by Delaney (1982, 1984, 1986, 1989), Bruce et al. (1982), and Delaney and Brusca (1985). The family Aegidae was treated by Brusca (1983) and Brusca and France (1992). Several analytical and summary papers have also appeared (Brusca and Wallerstein 1979b, Brusca and Iverson 1985, Brusca 1987, Brusca and Wilson 1991).

The earliest references to eastern Pacific marine isopods date from the mid-1800s and the work of James Dana, William Lockington, James Benedict, and Pearl Lee Boone. However, it was the pioneering 20-year research program of Harriet Richardson that laid the foundation of our modern knowledge regarding this fauna. Milton Miller, Robert Menzies, and George Schultz built on Richardson's foundation through the 1970s. However, almost all of this work was concerned with the temperate eastern Pacific, and there have been only a few studies of the Cirolanidae of the tropical eastern Pacific and until now no attempt at synthesizing the fauna. The history of cirolanid taxonomy in general was reviewed in Bruce's (1986a) excellent treatment of the Australian fauna.

METHODS AND TERMINOLOGY

Specimens upon which this study is based were obtained by field collecting and by loans from various museums. Field collections were made by Brusca and/or Wetzer in California, Mexico, Guatemala, Nicaragua, Costa Rica, Panama, Peru, the Galapagos Islands, Brazil, Uruguay, and various localities in the Caribbean. Field samples were taken by SCUBA and shore collecting, and included washes and 0.24–0.5-mm screenings of material from various habitats (rocks, algae, coral, coral rubble, sediment, etc.). All material was fixed and preserved in 70% ethyl alcohol and examined with dissecting and compound microscopes. Appendages were drawn with the aid of a camera lucida. Institutional abbreviations used in this paper are as follows:

AHF—Allan Hancock Foundation, University of Southern California, Los Angeles, California (all AHF specimens are now housed at LACM)

BMNH—The Natural History Museum, London [formerly the British Museum (Natural History)]

LACM—Los Angeles County Museum of Natural History, Los Angeles, California

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SDNHM—San Diego Natural History Museum, San Diego, California

SIO—Scripps Institution of Oceanography, University of California, La Jolla, California

SOSC—Smithsonian Oceanographic Sorting Center (USNM), Washington, D. C.

SMF—Senckenberg Museum, Frankfurt, Germany

UA—University of Arizona, Tucson, Arizona

UCR—Natural History Museum, Universidad de Costa Rica, San Jose, Costa Rica

USL—University of Southwestern Louisiana, Lafayette, Louisiana

USNM—National Museum of Natural History, Smithsonian Institution, Washington, D.C.

ZMUC—Zoological Museum, University of Copenhagen, Denmark

Other abbreviations used include PMS, plumose marginal setae; SEM, scanning electron microscope; coll., collector; det., determined by; m, meters; mm, millimeters; mi., miles; N., north; S., south; E., east; W., west.

The literature regarding terms used to identify the surfaces of pereopods is often confusing. Surfaces referred to by some workers as "anterior" have been referred to by others as "posterior." Similarly, workers have vacillated between the terms "inner" and "outer," and "medial" and "lateral." In part, the reason for this confusion is that in most isopods the anterior legs are usually oriented differently from the posterior legs (Brusca and Wilson 1991). In flabelliferans pereopods I–III are generally directed forward at an anterolateral angle, whereas pereopods IV–VII are generally directed backward at a posterolateral angle. To avoid confusion, we use the terms inferior (= ventral), superior (= dorsal), anterior, and posterior as indicated in Fig. 1 when describing pereopod anatomy. Thus, "inferior" refers to the pereopodal surface forming the concave curve of the ischium–dactylus. We use the term "medial" to describe the position of structures near or toward the animal's midline, and we reserve the term "lateral" for structures located away from the midline of the body, not in reference to the axis of particular appendages.

Similarly, the terms "setae" and "spines" have been used variously by different authors. Arthropod setae are generally defined as arising from well-developed sockets and being movable, except those which are secondarily immobilized because of heavy cuticularization. The sockets are formed by invaginations of the cuticle, not of the whole integument. Arthropod spines, on the other hand, regardless of their shape or size, are generally defined as not being articulated and are characterized by an evagination by the whole integument. The degree of development of setal sockets varies from elaborately sunken for heavy setae to delicately inserted for the fine setae on the tergal surfaces of many crustaceans. Although these definitions of "seta" and "spine" are widely accepted, they are rarely adhered to in the literature on isopods, and it is not always easy to discern articulations or the presence of sockets by light microscopy. Furthermore, at least in the isopod literature, there has been a tradition of referring to large, smooth, robust setae as "spines," especially if the socket is more or less immobilized. In keeping with terminology currently used in isopod systematics, we use the term "seta" for a long, thin, flexible, articulating cuticular process, and we reserve the term "spine" for a large, robust, rigid, cuticular process (whether or not a socket is discernable). We standardize the terminology used for spines by describing them as simple, apically forked, basally serrate, serrate trident, molariform, squamate, or circumplumose (Fig. 2). We standardize the terminology used for setae by describing them as simple, plumose, circumplumose, comb, serrate, serrate trident, or palmate (Fig. 2). The term PMS is restricted to the plumose marginal setae occurring

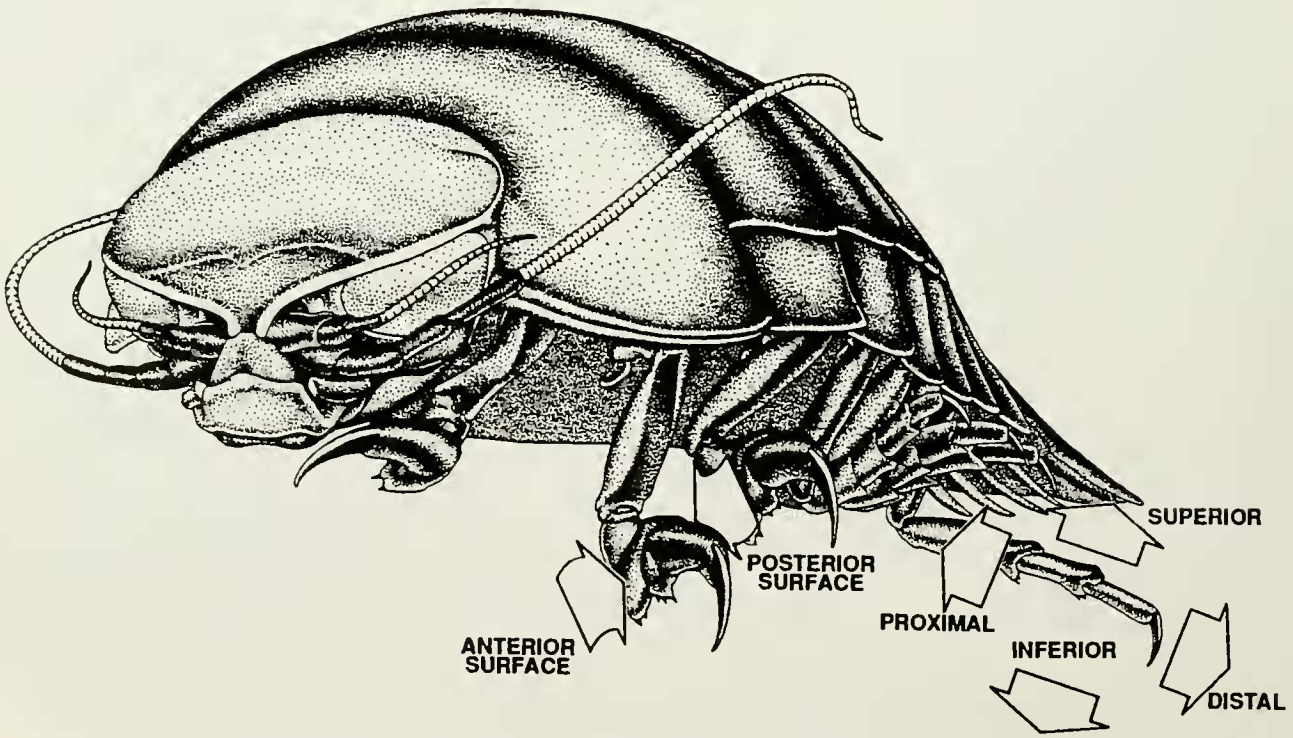

Figure 1. A cirolanid isopod (*Bathynomus giganteus*), illustrating terms used in the text to describe pereopods. In flabelliferan isopods pereopods I–III are generally directed forward at an anterolateral angle, whereas pereopods IV–VII are generally directed backward at a posterolateral angle.

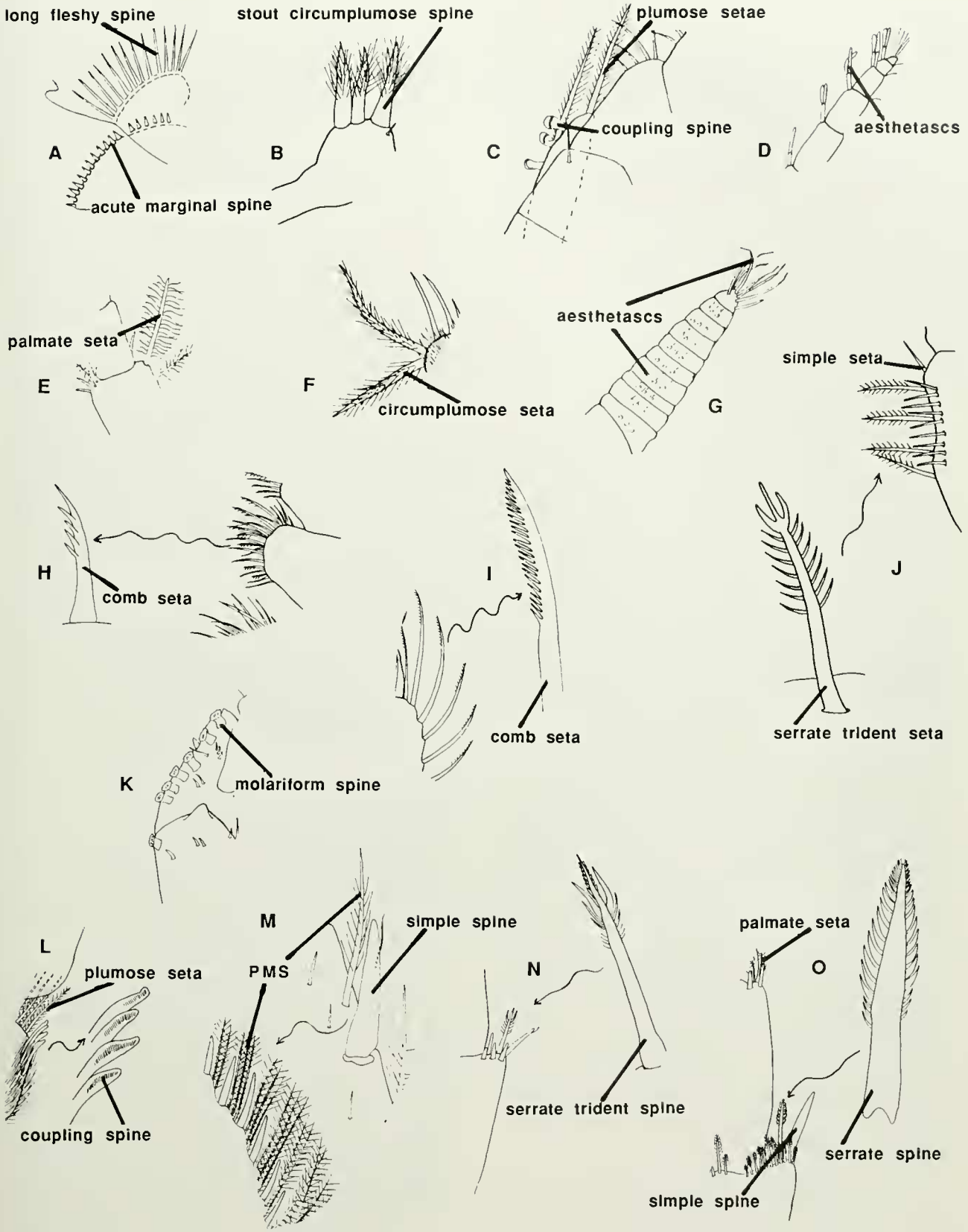

Figure 2. Some types of setae and spines found on cirolanid isopods. A, acute and long fleshy simple spines (mandible of *Metacirolana costaricensis*). B, stout circumplumose spines (maxillule of *Anopsilana oaxaca*). C, plumose setae and coupling spines (maxilliped of *A. oaxaca*). D, aesthetascs (antennule of *A. oaxaca*). E, palmate setae (antennule of *Natatolana carlenae* n. sp.). F, circumplumose setae (maxilla of *A. oaxaca*). G, aesthetascs (antennule of *N. carlenae* n. sp.). H, comb setae (maxilliped of *Cirolana harfordi*). I, comb setae (maxilliped of *C. harfordi*). J, serrate trident setae (maxilliped of *A. oaxaca*). K, molariform spines (pereopod I of *C. harfordi*). L, plumose setae and coupling spines (peduncle of pleopod 3 of *C. harfordi*). M, simple spines and PMS (uropod of *A. oaxaca*). N, serrate trident spines (pereopod VII of *A. oaxaca*). O, simple spines, serrate spines, and palmate setae (pereopod I of *C. harfordi*).

on the rami of the pleopods and uropods and on the posterior margin of the pleotelson. The term coupling spine is reserved for the specialized spines of maxillipedal endites and pleopodal peduncles.

In most Peracarida the dactylus terminates in a spinelike "claw," usually called the unguis, which may be marked off by a suture or immovable articulation. In many other malacostracans this terminal spine is distinct and freely articulating. In his early work, Hansen (1903) considered this free terminal spine an additional leg article, but he later to came to agree with Calman (1909) that it is simply an enlarged spine. In his revision of the isopod subfamily Lipomerinae (Asellota: Munnopsidae), Wilson (1989) described this fixed spine, or unguis, as "a modified seta on the tip of the dactylus." In most isopod suborders there are some genera in which this fixed terminal spine, or unguis, may be accompanied by one or more additional stout, fixed, clawlike spines arising near the base of the unguis. The size of these "secondary spines" ranges from very short to as large as the primary spine, or unguis, itself.

For example, in many Gnathiidea a "secondary spine" is present but small, while in the Calabozoidea and many Phreatoicidea, Oniscidea, Anthuridea, Sphaeromatidae, Cirolanidae, Limnoriidae, and others a "secondary spine" one-quarter to one-half the size of the unguis often occurs. In some Asellota the "secondary spine" may also be half the size of the unguis (e. g., *Munnogonium*), or even fully as large as the unguis (e. g., *Stenetrium*). In the asellotan genus *Joeropsis* there are often two secondary spines, both as large as the unguis.

Many authors refer to these "secondary spines" as "secondary ungui" and to such legs as biungulate (or triungulate when two "secondary spines" are present). However, the point at which small spines become large enough to warrant being called "secondary ungui" is subjective, and the literature is therefore unclear and inconsistent regarding the terms "secondary ungui," "bigungulate," and "triungulate." Because of this confusion, and because we presume all these stout fixed spines to be homologous in a general sense, we avoid the terms "secondary ungui" and "biungulate" and instead simply note the occurrence of additional spines at the base of the ungui when they are present.

Lengths of isopods were measured from the frontal margin of the cephalon to the posterior margin of the pleotelson by holding the animal (not unnaturally) flat and using a calibrated ocular micrometer. Numerical comparisons of structures given in the text (such as "endopod width 0.5 times exopod width") were obtained by measuring the greatest dimensions of the structures concerned, unless otherwise noted.

We give complete synonymies except where recent monographs have already done so. In the latter case, we provide synonymies subsequent to (and often expanding upon) the cited reference. Species descriptions are based on primary type material, with supplemental data (i. e., polymorphism) from other material examined. Primary types of most species are illustrated, and, for some, additional (Pacific) specimens are also figured. Some older type material is damaged, with obviously missing spines, setae, etc. Body measurements and ranges are based on all material examined. Taxa are treated in alphabetical order within each higher taxon. Localities listed under Material Examined are ordered from north to south and numbered sequentially. The species lists for each genus are updated from Bruce (1986a).

Several authors (e. g., Racovitza 1912, Menzies 1962a, Bruce 1986a, Kensley and Schotte 1989) have suggested various generic groupings within the Cirolanidae. However, as the number of genera has grown, discerning possible monophyletic groupings intuitively has become increasingly difficult [note Kensley's (1987) comments in this regard]. Furthermore, several of the existing genera could be nonmonophyletic (e. g., *Anopsilana*, *Cirolana*, *Metacirolana*). Therefore, until an analytical phylogenetic analysis is accomplished, we feel it is best to treat the genera separately rather than to contribute to the creation of numerous new names and combinations that will only continue to be altered and shuffled about until phylogenetic relationships have been properly assessed.

TAXONOMY

Order Isopoda Latreille, 1817

Suborder Flabellifera Sars, 1882

Family Cirolanidae Dana, 1853

Synonymy.—Emended and subsequent to Bruce (1986a:7).

Barnard 1914: 350A (as Eurydicidae). Brusca and Iverson 1985: 30. Kensley and Schotte 1989: 122.

Description.—Body symmetrical, usually sleek but occasionally ornamented, rough or nodulose, 2–6.5 times longer than wide. Eyes lateral, small to moderate in size, vestigial or absent in many subterranean and deep-water species. Frontal margin of cephalon evenly convex or produced into short rostrum (= rostral process); cephalon usually with posterolateral grooves ("incisions") and an interocular carina. Antennular peduncle 3-articulate, occasionally reduced to 2 articles; "scale" present (on third article) only in *Bathynomus*; in most taxa the third article is followed by a short fourth article of uncertain homology; flagellum multiarticulate. Antennal peduncle 5-articulate, occasionally reduced to 4 articles; flagellum multiarticulate. Frontal lamina, clypeus, and labrum distinct; free posterior margin of labrum concave. Mandible with fundamentally tridentate incisor, frequently with an accessory tooth on right or left mandible; spine row well developed and lobelike; lacinia apparently absent (see below); molar process flat, elongate and bladelike, with row of stout submarginal spines along upper (anterior) margin; palp 3-articulate (reduced to 2 articles in some species). Maxillule lateral (= outer) lobe with 10–14 apical spines; medial (= inner) lobe with 3–4 circumplumose spines; neither lobe ever forms a stylet (as in many flabelliferan families, e. g., Aegidae, Corallanidae, Cymothoidae, Tridentellidae). Maxilla setose, bilobed, outer lobe divided (maxilla of a single lobe in *Oncilorpheus*). Maxillipedal palp typically 5-articulate, articles never with hooked or strongly recurved spines; endite distinct, minute to large. Maxillipeds with epipod present only in gravid females.

Coxal plates on pereonites II–VII well developed, fused to tergites but with distinct suture lines; usually with oblique–transverse grooves running from anterior to posterior, but absent in many species. Pereopods ambulatory; I–III tend toward a grasping subprehensile form with dactyli moderately developed but almost always shorter than propodi.

Pleon usually with 5 free pleonites plus pleotelson; fusion and thus reduction in number of free pleonites occur in a number of genera. Lateral margins of pleonite 5 often overlapped by pleonite 4. Pleopods membranous, without ridges and only rarely with folds, often with lateral incisions and accessory lobes. Pleopod 5 endopod usually naked. Uropodal rami well developed, almost always lamellar and mobile, forming "tail fan" with pleotelson (exopod absent or reduced in some genera). Pleotelson and uropods usually with marginal setae and/or spines.

Remarks.—The name Cirolaninae was first used by Dana (published 1853, but dated 1852) and thus has precedence over Cirolanidae of Harger (1880) and Eurydicidae of Stebbing (1905). In their phylogenetic analysis of the Isopoda, Brusca and Wilson (1991) were unable to identify any unique synapomorphies of this family, suggesting the possibility that it is a paraphyletic group. Bruce (1986a) provided an excellent discussion of the morphological characters used in cirolanid taxonomy, and there is no need to repeat that information. However, we will comment on the antennal peduncles and mandibles.

The nature of the antennal peduncle in the Cirolanidae (indeed, the Isopoda in general) has been somewhat confused in the literature. Milne Edwards and Bouvier (1902) described the antennal peduncle of *Bathynomus* as 6-articulate. However, they appear to have mistaken the large articulating (arthroidal) membrane between articles 1 and 2 for an extra article, as noted by Bruce (1986a). Hansen (1903) also described the antennal peduncle of *Bathynomus* as 6-articulate, focusing on a minute strip of sclerotized cuticle at the base of the peduncle, at the edge of the articulating membrane, that he considered to be the vestige of a proximal antennal article, or precoxa. Hansen's conclusion that this piece of cuticle is homologous to a precoxal article was based on his observation that it moved ("articulated") within the antennal socket when the antenna was moved. Hansen (1903) noted similar conditions in several species of *Cirolana*, and later (1905, 1916) he added *Conilera* to the list of cirolanid genera with 6-articulate antennal peduncles. In his 1925 review, Hansen concluded that the 6-articulate condition was primitive for the Isopoda as a whole. Thus, Hansen's view was that the isopods' antennal peduncle primitively constituted a 3-articulate sympod (Hansen's "basipodite") combined with 3 additional basal articles of the flagellum. This homology was primarily based on the presence of a "scale" (or "squama") on the third antennal article of the many Asellota that have 6-articulate antennae. Calman (1909) and Wägele (1983) agreed with Hansen's conclusion that the 6-articulate condition is primitive for isopods.

We are not entirely convinced that the 6-articulate antennal peduncle is primitive in the Isopoda, or that it occurs among the Cirolanidae. Brusca and Wilson (1991) examined the basal cuticular pieces noted by Hansen (and others) on the articular membrane of the antenna of *Bathynomus giganteus* and *B. doederlini* and also found it to move when the antenna is moved. However, they noted that this piece does not articulate with any other article, or with the head, but simply floats free on the membrane. Similar free-floating cuticular pieces occur in many other genera of Cirolanidae. Bruce (1986a) commented on these structures, noting them in at least 12 Australian genera. Splitting and fragmentation of the proximal antennal article is common in many isopod groups (e. g., Ligiamorpha, Anthuridea, Phreatoicidea), and in cirolanids these arthrodial sclerites may be free-floating pieces fractured off the first peduncular article (or off the head). We believe that the homologization of these arthrodial sclerites with a precoxal article is still speculative. Among the Malacostraca, an antennal precoxa (and hence a 3-articulate sympod) occurs unquestionably only in the mysidaceans, tanaidaceans, and asellotan and microcerberid isopods. In all other malacostracans the sympod comprises 2 articles, and the rami (or scale) arise from the second article. Brusca and Wilson (1991) discussed this unresolved matter in more detail.

The nature of the spinose lobe on the cirolanid mandible, between the molar and incisor processes, is also still unsettled. Some researchers (e. g., Kensley 1984, 1987, 1989; Müller 1991) refer to it as a "spine row," while others (e. g., Bruce and Javed 1987, Bowman and Iliffe 1983, 1987, 1991) have called it a lacinia mobilis. Most recently, Bruce (1991, *in litt.*) has concluded that it is a true spine row, the lacinia being absent in most cirolanids. In Bruce's view, a lacinia may occur only in *Bathynomus*, some species of *Metacirolana*, *Politolana dasyprion*, *Cirolana binyana*, and perhaps a few others, and it is represented by the distal biting edge on the lobe bearing the spine row, which takes the form of a large blunt tooth in these taxa. However, a similar distal sclerotized biting edge occurs in other flabelliferans as well, e. g., *Phoratopus remex* (see Bruce 1981c). Among cirolanids, specialization of the distal region of the spine row is not uncommon, but it presents no clear pattern among the species or genera. The distal region may be sclerotized, or bear a sclerotized tooth or biting edge, as in *Bathynomus*, *Neocirolana maculata* (see Bruce 1986a), *Metacirolana basteni* (see Bruce 1980a), and *Metacirolana rugosa* (see Bruce 1980b). Furthermore, the most distal spine group of the spine row often differs from the more proximal spines, as seen in *Natatolana pastorei* (see Wägele and Bruce 1989) and *Atarbolana exoconta* (see Bruce and Javed 1987). The precise homology of these structures is not yet understood. However, because the distal sclerotized biting edge on *Bathynomus* and others does not articulate, and because specialization of the most distal spines is common, we tend to regard these simply as a specialized region or specialized spines of the spine row. Thus it appears that a lacinia mobilis is absent in the Cirolanidae.

The majority of cirolanid species are free-living predators or carnivorous scavengers (Johnson 1976a, Holdich 1981, Stepien and Brusca 1985, Bruce 1986a). Species of *Cirolana*, *Conilera*, and *Politolana* are often captured in offshore benthic traps baited with dead animals (e. g., Wetzer et al. 1987, Biernbaum and Wenner 1993). Species of *Cirolana* and *Natatolana* are often reported attacking both living and dead animals, as reviewed by Stepien and Brusca (1985). Certain predaceous species are occasionally referred to as parasites, because they are often found temporarily feeding on the surface of fishes or large invertebrates. However, most if not all of these species cling to the prey only long enough to take a meal, and they are therefore best considered micropredators. The mandibles of cirolanids are well suited for biting and chewing, and many can inflict a reasonably painful bite on swimmers (e. g., see discussion of *Excirolana*). Many species burrow in sand or live under rocks, while others spend much of their lives in algal turfs, mussel beds, kelp holdfasts, the chambers of sponges, or burrows of other animals. In almost all cases these habitats are utilized opportunistically. Most cirolanids are good swimmers, entering the water column at various times. Trapping suggests that many species are nocturnal. Experimental evidence suggests that at least one species, *Cirolana diminuta*, emerges nocturnally into the water column to prey on certain nearshore fish species (Stepien and Brusca 1985). Many species are known to have endogenous activity rhythms [see Hastings (1981) for an introduction to that literature, and DeRuyck et al. (1991) for a recent summary]. Cirolanids are most common in shallow-water habitats (intertidal and subtidal), where they are often abundant.

Forty-six genera are currently recognized in the family Cirolanidae. There has probably been some measure of over-splitting, however, and several genera may not be monophyletic. A careful phylogenetic analysis of the group is needed. A number of species are troglobitic (19–20 species in North America), others occur in fresh water, and still others are found in the deep sea. Of the 46 genera, 8 are known from the tropical eastern Pacific at this time.

Biogeography.—The historical biogeography of the eastern Pacific Cirolanidae cannot be adequately addressed until phylogenetic analyses of this large family and its Pacific genera have been completed. However, some generalities are apparent from the data derived from this study. Eighteen species in 8 genera have been identified from the tropical eastern Pacific zoogeographic region. Seven of these are newly described in this paper. Of these 18 species, 15 (83%) may be regarded as tropical species; 3 of these (*Eurydice caudata*, *Natatolana carlenae* n. sp., and *Excirolana braziliensis*) extend their ranges somewhat into the warm temperate region adjacent to the tropics. The 3 remaining species are *Cirolana harfordi*, a temperate species (eastern Pacific distribution: British Columbia to central western Baja California (with a single record from the southern Gulf of California), *Cirolana diminuta*, a California and Gulf of California species (warm temperate–subtropical), and *Natatolana californiensis*, a southern California species for which we have a single record from the Gulf of California. *Excirolana braziliensis* is an essentially tropical species in the western Atlantic, Caribbean, and eastern Pacific, but in the last region it extends its range south to central Chile. Four species (22%) are amphi-American in distribution (*Anopsilana browni*,

Cirolana parva, *Excirolana braziliensis*, and *E. mayana*). One species is endemic to the Galapagos Islands (*Metacirolana calypso* n. sp.), and one is endemic to the Gulf of California (*Cirolana nielbrucei* n. sp.).

Compared to the Caribbean cirolanid fauna, which contains approximately 36 species in 16 genera (Kensley and Schotte 1989), that of the tropical eastern Pacific is relatively depauperate. All tropical eastern Pacific genera except *Conilera* also occur in the Caribbean. The biogeographic history of *Conilera* is enigmatic, as its only two undisputed species are currently known from the northern Atlantic (*C. cylindracea*) and Ecuador (*C. bullisi* n. sp.). That the eastern Pacific isopod fauna has strong ties to the Caribbean fauna is evinced by the number of amphi-American species (4 species of Cirolanidae; at least 14 isopod species altogether) and the large number of probable sister species (i. e., geminate species), such as *Oncilorpheus stebbingi* (Caribbean) and *O. jerrybarnardi* n. sp. (Pacific). Two species marginally occurring in the tropical eastern Pacific, *Cirolana harfordi* and *Natatolana californiensis*, are clearly northern Pacific temperate intruders in the tropics.

Although some Cirolanidae occur in deep water, and others are fresh water or cave dwellers, the majority of species in the family inhabit shallow marine waters, living from the littoral region to depths shallower than 500 m. Of the eastern Pacific species, all but four (*Natatolana californiensis*, *N. carlenae* n. sp., *Oncilorpheus jerrybarnardi* n. sp., and *Metacirolana calypso* n. sp.) are littoral or shallow-water forms, and six may be regarded essentially littoral (rarely occurring in the sublittoral region): *Cirolana harfordi*, *C. namelessensis* n. sp., *Metacirolana costaricensis*, *Excirolana braziliensis*, *E. chamensis*, and *E. mayana*.

World list of genera.—

1. *Annina* Budde-Lund, 1908.
2. *Anopsilana* Paulian and Deboutteville, 1956.
3. *Antrolana* Bowman, 1964.
4. *Arubolana* Botosaneanu and Stock, 1979.
5. *Atarbolana* Bruce and Javed, 1987.
6. *Bahalana* Carpenter, 1981.
7. *Bathylana* Kensley, 1989.
8. *Bathynomus* Milne Edwards, 1879.
9. *Booralana* Bruce, 1986.
10. *Calyptolana* Bruce, 1985.
11. *Cartetolana* Bruce, 1981.
12. *Ceratolana* Bowman, 1977.
13. *Cirolana* Leach, 1818.
14. *Cirolanides* Benedict, 1896.
15. *Colopisthus* Richardson, 1902.
16. *Conilera* Leach, 1818.
17. *Conilorpheus* Stebbing, 1905.
18. *Creasericlla* Rioja, 1953.
19. *Dolicholana* Bruce, 1986.
20. *Eurydice* Leach, 1815.
21. *Eurylana* Jansen, 1981.
22. *Excirolana* Richardson, 1912.
23. *Faucheria* Dollfus and Viré, 1905.
24. *Gnatholana* Barnard, 1920.
25. *Hansenolana* Stebbing, 1900.
26. *Haptolana* Bowman, 1966.
27. *Limicolana* Bruce, 1986.
28. *Metacirolana* Kussakin, 1979.
29. *Mexilana* Bowman, 1975.
30. *Natatolana* Bruce, 1981.
31. *Neocirolana* Hale, 1925.
32. *Oncilorpheus* Paul and Menzies, 1971.
33. *Orphelana* Bruce, 1981.
34. *Parabathynomus* Barnard, 1924.
35. *Politolana* Bruce, 1981.
36. *Pontogelos* Stebbing, 1910.
37. *Pseudaega* Thomson, 1884.
38. *Pseudolana* Bruce, 1979.
39. *Saharolana* Monod, 1930.
40. *Skotobaena* Ferrara and Monod, 1972.
41. *Speocirolana* Bolivar and Pieltain, 1950.
42. *Sphaerolana* Cole and Minckley, 1970.
43. *Sphaeromides* Dollfus, 1897.
44. *Turcolana* Argano and Pesce, 1980.
45. *Typhlocirolana* Racovitza, 1905.
46. *Xylolana* Kensley, 1987.

Key to the Genera of Cirolanidae Known from the Eastern Pacific

1. Body elongate (length more than 4 times width); exopod of pleopod 1 indurate and operculiform to pleopods 2–5 2
— Body not elongate (length 2.0–3.5 times width); exopod of pleopod 1 not indurate and operculiform to pleopods 2–5 3
2. Endopods of pleopods 2–5 without PMS; maxillary lobes reduced and fused into single piece; first article of antennule not articulated at right angle to rest of antennule; outer (lateral) angle of uropodal peduncle not produced, apex rounded (not acute) ..... *Oncilorpheus*
— Endopod of pleopod 5 only without PMS; maxillary lobes not reduced and fused, medial and lateral lobes distinct (outer lobe bifurcate); antennule article 2 arising at right angle to article 1; outer (lateral) angle of uropodal peduncle produced, with acute apex, almost as long as inner (medial) angle ..... *Conilera*
3. Antennule article 1 longer than articles 2 or 3; antennule article 2 arising at right angle to article 1; maxillipedal endite barely reaching (or extending barely beyond) first palp article; maxillipedal endite without coupling spines; frontal lamina narrow, anterior (apex) freely projecting; clypeus forming a ventrally projecting triangular blade; antenna with 4 peduncular articles; antenna long, extending beyond pereonite VII; lateral margins of pleonite 5 not encompassed by pleonite 4 *Eurydice*
— Antennule article 2 or 3 longest; antennule article 2 not arising at right angle to article 1; maxillipedal endite extending well beyond first palp article, usually to distal margin of 2nd palp article; maxillipedal endite with coupling spines; frontal lamina variable; clypeus variable; antenna with 4 or 5 peduncular articles; antenna length variable; lateral margins of pleonite 5 may or may not be encompassed by pleonite 4 4
4. Antennule peduncle article 2 or 3 longest; clypeus projecting ventrally 5
— Antennule peduncle article 3 always longer than 1 or 2; clypeus short, broad, flat, and sessile, not projecting ventrally 6
5. Mandibular incisor usually with accessory tooth on left mandible; rostrum large and usually apically spatulate, separating antennules and confluent with (or fused to) frontal lamina; frontal lamina long and narrow; pleotelson with a pair of shallow submedian pits; pleopod endopods 2–5 or 3–5 without marginal PMS; medial angle of uropod only weakly produced; uropodal endopod outer (lateral) margin with a small pit or notch ..... *Excirolana*
— Mandibular incisor usually with accessory tooth on right mandible; rostrum small to moderate, never spatulate and never separating antennules; frontal lamina broad, apex dilated and projecting; pleotelson without a pair of shallow submedian pits; pleopod endopod 5 only lacking PMS; medial angle of uropod strongly produced into an acute process; uropodal endopod without a pit or notch on the outer (lateral) margin ..... *Metacirolana*
6. Pereopods V–VII with basis markedly flattened and provided with long setae, pereopod VII with medial row of long setae on

posterior surface; frontal lamina long and narrow, length 3–4 times width; male appendix masculina arising basally or submedially on endopod; pleopod endopod 5 only without PMS ..... *Natatolana*

— Pereopods V–VII not markedly flattened and bearing long setae; frontal lamina rectangular, pentangular, or round, length no more than 2 times width; male appendix masculina always arising basally on endopod; pleopods 3–5, or only 5, without PMS 7

7. Pleopods 3–5 without PMS on endopods; posterolateral region of pleonite 3 extends posteriorly to or beyond posterior margin of pleonite 5; endopods of pleopods 3–4 reduced in size (in comparison to those of *Cirolana*); frontal lamina pentagonal or subquadrate, barely longer than broad; short rostrum always present; brackish or fresh water only ..... *Anopsilana*

— Only pleopod 5 without PMS on endopods; posterolateral region of pleonite 3 variable; endopods of pleopods 3–4 not much smaller than exopods; frontal lamina subquadrate, round, or pentagonal, usually distinctly longer than broad; with or without a short rostrum; marine, brackish, or fresh water ..... *Cirolana*

Anopsilana Paulian and Deboutteville, 1956

Type species.—*Anopsilana poissoni* Paulian and Deboutteville, 1956, by monotypy. Type material at the Institut Scientifique de Madagascar, Tsimbazaza, Antananarivo, Madagascar.

Synonymy.—Emended and subsequent to Bruce (1992:1).

Anopsilana. Monod 1976: 135. Bowman and Franz 1982: 522. Botosaneanu et al. 1986: 412. Bowman and Iliffe 1987: 347.

Description.—Body 2.5-3.0 times longer than wide. Eyes moderate in size; troglobitic species usually blind. Frontal margin of cephalon produced into a minute or short acute rostrum; cephalon weakly to strongly immersed in pereonite I. Frontal lamina subquadrate, pentagonal, or subpentagonal/ovate, as long as broad or longer than broad, apex projecting or sessile, rounded or truncate; clypeus flat (sessile), short, and broad; labrum equal to or narrower than clypeus. Antennular peduncle 3- or 2-articulate (i. e., articles 1 and 2 often fused); article 3 longest, about 5 times as long as wide; article 2 not arising at right angle to article 1; flagellum short but not compressed. Antennal peduncle 5-articulate; articles 1–3 short and subequal in length, articles 4–5 elongate (length greater than 2.0 times width), 5 longest; flagellum very setose. Mandible with broad tridentate incisor, but middle cusp on left mandible usually reduced; palp extends about to apex of incisor, its middle article longest, middle and distal articles with setae; spine row forms a well-developed rounded lobe with short simple spines. Maxillule medial lobe with 3 stout circumplumose spines and 1 or 2 small simple setae; lateral lobe gnathal surface with 10–14 stout spines. Maxilla medial lobe short and truncate, usually with 2 long circumplumose setae and numerous shorter plumose setae and/or simple setae. Maxillipedal palp 5-articulate, article 3 wider than 4; endite with 2 or 3 coupling spines and long plumose setae.

Pereonite I longest, usually twice as long as pereonite II; coxal plates II–VII becoming larger posteriorly, posterolateral angles increasingly acute posteriorly. Pereopods increasing in length posteriorly; pereopods V–VII spinose, with bases not markedly flattened. Penial papillae (penes) absent or minute.

Pleon of 5 free pleonites; pleonite 1 entirely or largely covered by pereonite VII; posterolateral region of pleonite 3 extends posteriorly to or beyond posterior margin of pleonite 5; pleonite 4 lateral margins rounded, completely encompassing lateral margins of pleonite 5. Peduncles of pleopods 1–5 wider than long, lateral margins without accessory lobes; endopods always slightly smaller than exopods, especially on pleopods 3–5. Pleopod 1 not operculate; appendix masculina stout, arising basally or subbasally on endopod of pleopod 2. Pleopodal endopods 1–2 with PMS, 3–5 without PMS; endopods of pleopods 3–5 smaller than exopods. Proximomedial angle of pleopodal endopod 5 produced and lobelike; peduncle of pleopod 5 small, without coupling spines or plumose setae on medial margin. Pleotelson apex acute or subacute, never indented. Uropodal peduncle medial angle strongly produced and acute; medial margin of exopod with numerous simple spines and PMS.

Remarks.—Bruce (1986a, 1992) synonymized *Troglocirolana* and *Haitilana* with *Anopsilana*, treated the Australian species, and reviewed the genus. *Anopsilana* is distinguished from the closely related genus *Cirolana* by its different pleopod morphology (see key). The 15 species in the genus inhabit brackish, anchialine, and fresh water, including 7 species known from caves, wells, and other subterranean habitats. A number of authors have stated that *Anopsilana* species lack penes; however, penes are present, though small, in mature males of at least *A. oaxaca* and *A. browni*. Females tend to be larger and less ornamented than males. Three species occur in the tropical eastern Pacific region, *Anopsilana oaxaca*, *A. browni*, and *A. aleci* n. sp. In all the species of *Anopsilana* we have examined, a stout simple seta occurs on the proximolateral margin of the exopod on pleopod 1. The genus appears to lack any unique synapomorphies, suggesting it may not be a monophyletic group.

World list of species.—

1. *A. acanthura* (Notenboom, 1981). Haiti.
2. *A. aleci* n. sp. Miraflores Locks, Panama Canal.
3. *A. barnardi* Bruce, 1992. Queensland, Australia.
4. *A. browni* (Van Name, 1936). Cuba, Belize, and Pacific Costa Rica.
5. *A. conditoria* Bruce and Iliffe, 1993 [but dated 1992]. Philippines (from an anchialine cave pool).
6. *A. crenata* Bowman and Franz, 1982. Grand Cayman Island.
7. *A. cubensis* (Hay, 1903). Cuba.
8. *A. jonesi* Kensley, 1987. Belize.
9. *A. lingua* Bowman and Iliffe, 1987. Palau (from a cave pool).
10. *A. luciae* (Barnard, 1940). South Africa.
11. *A. oaxaca* Carvacho and Haasmann, 1984. Oaxaca, Mexico, and Clipperton Island.
12. *A. poissoni* Paulian and Deboutteville, 1956. Madagascar.
13. *A. pustulosa* (Hale, 1925). Australia, East Africa, Mozambique, Madagascar, Aldabra, India, and Papua New Guinea.
14. *A. radicicola* (Notenboom, 1981). Haiti.
15. *A. willeyi* (Stebbing, 1904). East Africa to Australia, including Sri Lanka and India.

Key to Tropical Eastern Pacific *Anopsilana* Species

1. Left maxilliped with 3 coupling spines; pleotelson with 10–14 apical spines; pleopod 1 peduncle with 3 coupling spines; uropodal exopod's lateral (outer) margin with 9–11 spines; uropodal endopod with 6–8 spines on lateral (outer) margin ..... *A. oaxaca*

— Left maxilliped with 2 coupling spines; pleotelson with 8 apical spines; pleopod 1 peduncle with 4–5 coupling spines; uropodal exopod with 0 or 8 spines on lateral (outer) margin; uropodal endopod with 2 spines on lateral (outer) margin 2

2. Dorsum of pereon ornamented with submedial tubercles; pleotelson with median longitudinal ridge; uropodal rami extend to or slightly beyond pleotelson apex; pleonite 1 entirely hidden by pereonite VII; antennae reach pereonite IV; pereopod VII ischium's inferior margin rugose; uropodal exopod with 5 spines on medial (inner) margin ..... *A. browni*

— Dorsum of pereon smooth, not ornamented; pleotelson without medial ridge; uropodal rami much longer than pleotelson; pleonite 1's lateral margins visible in dorsal aspect; antennae reach pereonite II or III; pereopod VII ischium not rugose; uropodal exopod with 3 spines on medial (inner) margin ..... *A. aleci* n. sp.

Anopsilana aleci n. sp.
Figs. 3B, 4, 5

Type material examined.—Male holotype (USNM 252744) and 3 paratypes (1 male, 2 females) (SDNHM Cat. No. 2222): Panama, Panama Canal, Miraflores Locks, upper east chamber, formalin wash of sticks, rocks, etc., on bottom of chamber; 17 Jan. 1971; coll. P. W. Glynn.

Description of male.—Cephalon devoid of tubercles (Fig. 3B). Antennules short, extended just past posterior margin of cephalon; bases separated by rostrum, flagellum of 10 to 12 articles (Fig. 4A). Antennae extend to posterior margin of pereonite II; flagellum of about 25 articles (Fig. 4B). Frontal lamina subrectangular, anterior margin rounded; labrum slightly narrower than clypeus (Fig. 4C). Mandibular spine row with 6 stout simple spines; molar process with about 19 small acute spines; proximal palp article with 1

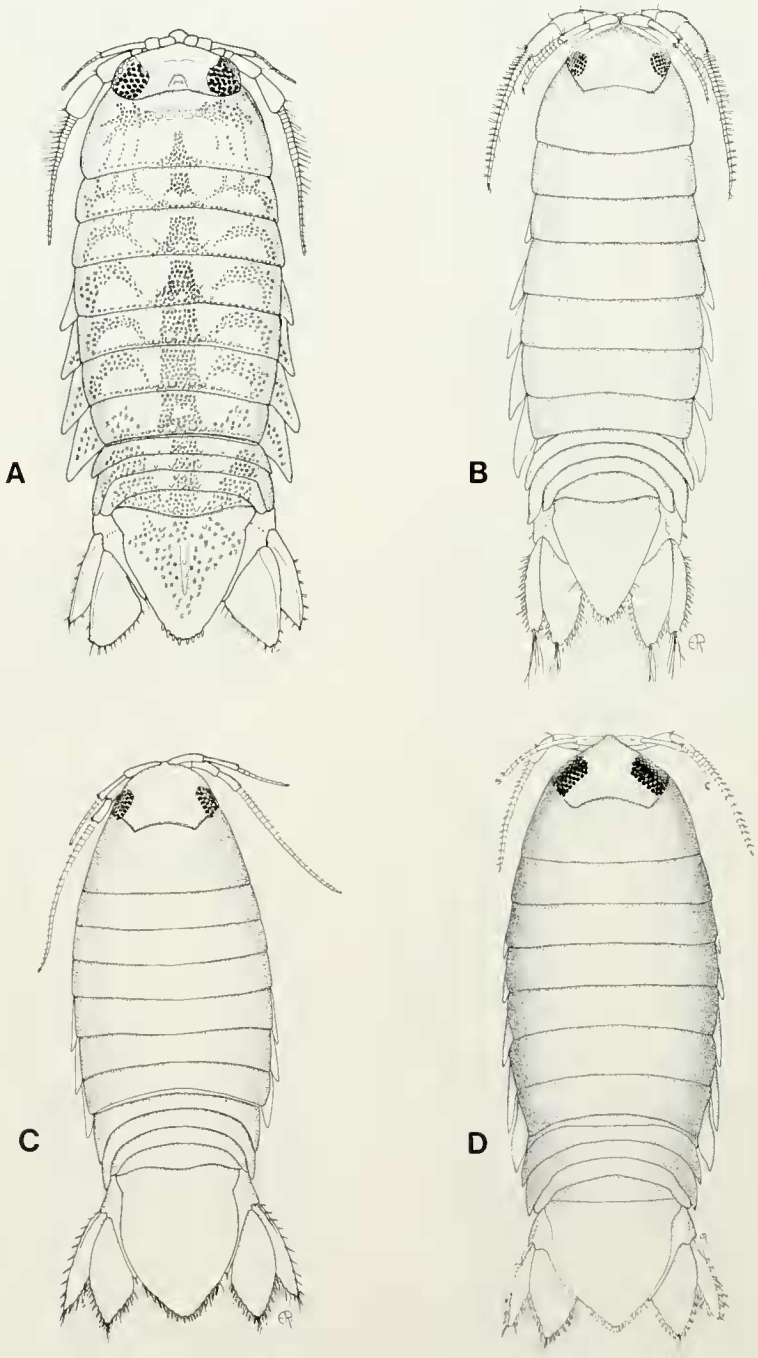

Figure 3. *Anopsilana* of the tropical eastern Pacific, dorsal views: A, *A. browni* (SDNHM A.0007), male. B, *A. aleci* n. sp. (USNM 252744), holotype, male. C, *A. oaxaca* (USNM 102239), male. D, *A. oaxaca* (SIO C3826), female.

simple seta; middle palp article with 4 plumose and about 11 simple setae; distal article with 2 comb and about 11 simple setae (Fig. 4D). Maxillule medial lobe with 1 short simple spine and inner protuberance; lateral lobe with about 12 stout apical spines, many with short barbs, and about 6 minute subapical spines (Fig. 4E). Maxilla medial lobe with 2 long circumplumose setae, 4 shorter plumose setae, and about 8 simple setae; lateral lobes with about 9 and 4 simple setae, respectively; 1 simple seta lies proximal to base of lateral lobes, and simple setae lie on their lateral margin (Fig. 4F). Maxillipedal palp with simple setae and comb setae as figured; endite short, with 2 coupling spines and about 4 apical plumose setae on both left and right endites (Fig. 4G).

Pereon devoid of dorsal tubercles or setae. Posterior angles of coxae VII very acute and produced past anterior margin of pleonite 3. Coxae III–VII visible in dorsal view (Fig. 3B). Pereopod I short; inferior distal angle of ischium with 1 simple seta; inferior margin of carpus with about 7 short blunt simple spines and simple setae; inferior distal angle of carpus with 1 spine and 1 seta; inferior margin of propodus with 3 spines and a cluster of distal setae; dactylus with small setae at base of unguis (Fig. 5A). Pereopod IV

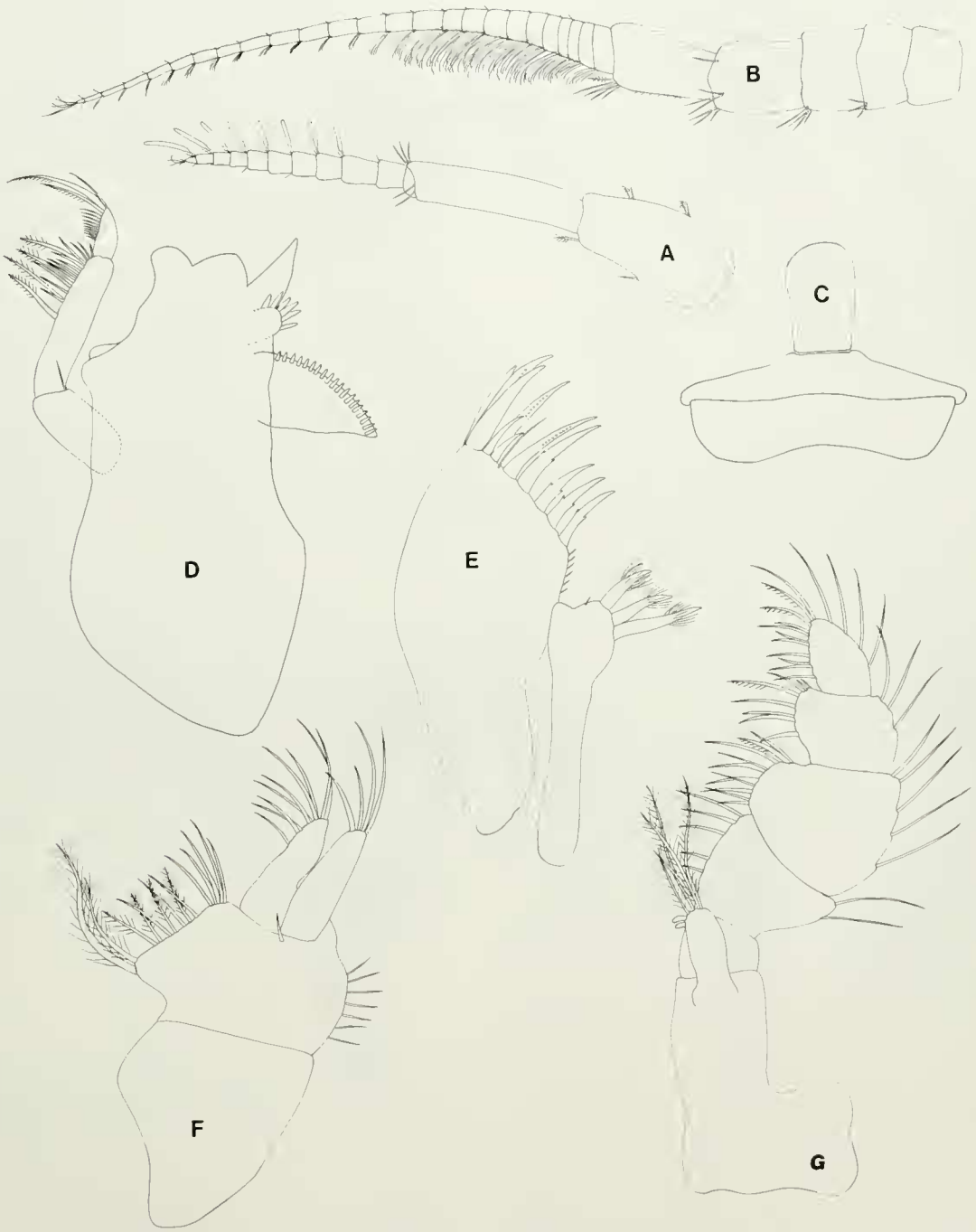

Figure 4. *Anopsilana aleci* n. sp. (USNM 252744), holotype, male. A, antennule (left). B, antenna (left). C, frontal lamina, clypeus, and labrum. D, mandible (right). E, maxillule (right). F, maxilla (right). G, maxilliped (right).

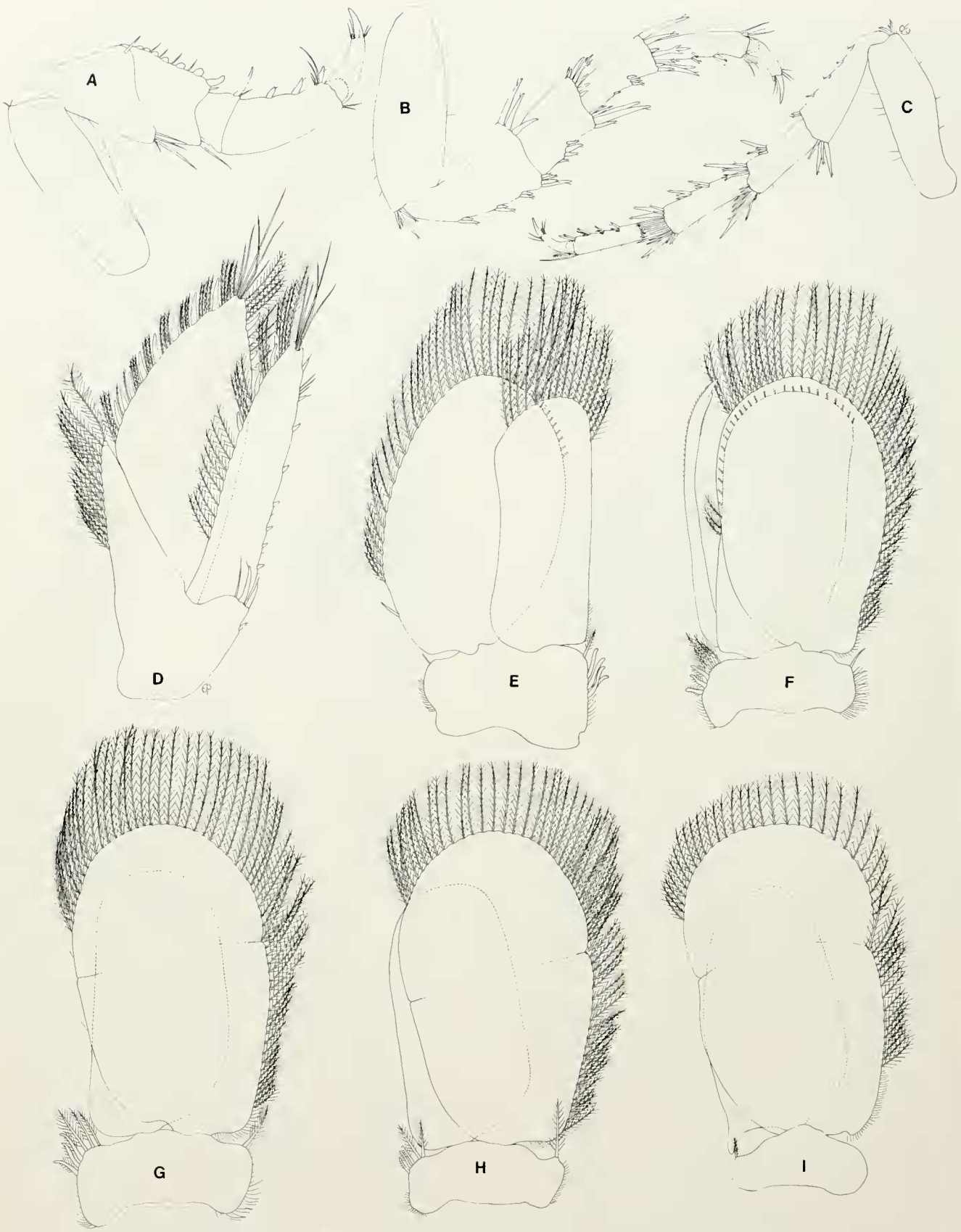

Figure 5. *Anopsilana aleci* n. sp. (USNM 252744), holotype, male. A, pereopod I (right). B, pereopod IV (right). C, pereopod VII (right). D, ventral view of uropod (right). E, pleopod 1 (right). F, pleopod 2 (right). G, pleopod 3 (right). H, pleopod 4 (right). I, pleopod 5 (right).

long, ambulatory, with setae and simple and serrate trident spines as figured (Fig. 5B). Pereopod VII long, ambulatory, with many simple and trident spines as figured (Fig. 5C). Penes absent or at least not observed.

Pleon devoid of dorsal tubercles or setae. Pleopodal rami with PMS as figured (Figs. 5E–I). Pleopod 1: peduncle's medial margin with 1 plumose seta, 4 coupling spines, and numerous simple setae; lateral margin with 1 large seta and numerous simple setae; exopod 1.8 times width of endopod; exopod with 1 simple seta on proximolateral margin (Fig. 5E). Pleopod 2: peduncle's medial margin with 3 coupling spines, 4 plumose setae, and many simple setae; lateral margin with 1 simple spine and many simple setae; exopod 1.4 times width of endopod; appendix masculina just reaches or extends barely beyond tip of exopod, apex narrow with small subapical lobe (Fig. 5F). Pleopod 3: peduncle's medial margin with 3 coupling spines, 3 plumose setae, and many simple setae; lateral margin with 1 plumose seta and many simple setae; exopod 1.4 times width of endopod, with short incisions on lateral and medial margins (Fig. 5G). Pleopod 4: peduncle's medial margin with 3 coupling spines, 2 plumose setae, and many simple setae; lateral margin with 1 plumose seta and many simple setae; exopod 1.5 times endopod width, with short incisions on medial and lateral margins (Fig. 5H). Pleopod 5: peduncle with 1 plumose seta on lateral margin; exopod 1.4 times width of endopod, with incisions on lateral and medial margins (Fig. 5I).

Pleotelson subtriangular, slightly sinuate near base, with PMS and 8 apical spines, without dorsal tubercles (Fig. 3B). Uropods much longer than pleotelson and taper distally; each ramus with small apical notch containing long simple setae. Uropodal exopod 0.4 times width of endopod and slightly shorter; lateral margin with 8 simple spines and PMS, medial margin with 3 large simple spines and PMS. Uropodal endopod: medial margin with 8 large simple spines and PMS; lateral margin with 2 simple spines and PMS. Uropodal peduncle with PMS on medial margin and 1 simple spine on lateral margin, 2 large ventral spines and 1 simple seta near base of exopod (Fig. 5D).

Female.—Similar to male.

Size.—Maximum length to 11.5 mm.

Distribution.—Known only from the Miraflores Locks of the Panama Canal. It is unlikely that this species occurs only in the Miraflores Locks, a small and continually disturbed habitat. Future collecting efforts may find it upstream, in the Gatun Lake region.

Remarks.—The long distally tapering uropods of this species are similar to, though even longer than, those of *Anopsilana browni*. *Anopsilana aleci* differs from *A. browni* in lacking the dorsal and pereopodal ornamentation of the latter. *A. aleci* differs from *A. oaxaca* in many characters, including the length and spination of the uropods and pleotelson and the shape of the frontal lamina.

Etymology.—This is species is named for the senior author's son, Alec, a consummate fisherman who, in his youth, provided companionship on countless collecting trips to the shores of the Sea of Cortez.

Anopsilana browni (Van Name, 1936)
Figs. 3A, 6–8

Cirolana browni Van Name, 1936: 423. Bruce 1985: 714; 1986a: 219. Kensley and Schotte 1989: 125.

Type material examined.—(1) Male holotype and female allotype (AMNH 6519): Cuba, Santa Clara Province, Danny's River, 3 mi. below Rodas; June 1918; coll. B. Brown. (2) 6 paratypes (AMNH 6536): Same data as holotype.

Other material examined.—Eastern Pacific specimens: (3) Costa Rica, Puntarenas Province, Gulf of Nicoya, Punta Morales, from burrows of *Sphaeroma peruvianum* (Isopoda: Sphaeromatidae) in roots of *Rhizophora mangle* (red mangrove); SDNHM A.0005, 8 Sept. 1987, 1 specimen, and SDNHM A.0007, 16 Dec. 1987; 1 specimen; both coll. W. Szelistowski; the latter apparently with 2 *Sphaeroma* in burrow.

Description of male (based on Pacific specimens).—Cephalon only moderately wide; anterior margin steeply inclined; a large, low, medial bifurcate tubercle and a medial transverse incision between eyes; rostrum minute. Eyes subquadrate in outline, separated by nearly 3 times their diameter. Antennules short, extended to middle of pereonite I, with simple and palmate setae and aesthetascs as figured; peduncular article 3 twice as long as article 2; flagellum of 10–16 articles (Fig. 7A). Antennae long, reaching posterior margin of pereonite III or IV; flagellum of 30–36 articles with proximal articles shorter than distal articles; proximal articles with very long setae as figured (Fig. 7B). Frontal lamina pentagonal; labrum as wide as clypeus; anterior margin of clypeus concave, posterior margin of labrum broadly concave (Fig. 6A). Mandibular spine row with about 9 simple spines; molar process with about 26 small acute spines; middle palp article with 4 long serrate setae and numerous shorter serrate and simple setae; distal palp article with about 8 simple and 2 plumose setae as figured; right incisor strongly tridentate, middle cusp of left incisor reduced to a wavy edge (Fig. 6B). Maxillule medial lobe with protuberance on lateral margin and 2 small simple setae; lateral lobe with about 10 long simple spines (Fig. 6C). Maxilla medial lobe with about 4 long simple setae and 15 circumplumose setae, 2 most posterior circumplumose setae very long; lateral lobes with about 5 and 14 long simple setae, respectively (Fig. 6D). Left and right maxillipedal endites with 2 and 3 coupling spines, respectively, and 4 long plumose setae (only 3 figured, one broken off); palp articles with long simple setae, apical article also with comb setae (Fig. 6E).

Body stout, strongly convex, broadest at pereonites III–IV. Pereonites II–VII subequal in length. Pereon with low tubercles; a row of 4 small medial transverse tubercles ornaments anterior third of pereonite I, becoming smaller laterally and tapering off into a faint transverse ridge; a row of 4–6 medial, posterior, submarginal tubercles occurs on pereonites III–VI, being largest medially and increasing in size on posterior pereonites. Coxae IV–VII visible in dorsal view. Pereopod I short; inferior margin of merus with 5 large molariform spines and a few simple setae, distal superior margin with simple setae; inferior margin of carpus with 1 long simple seta; propodus with 2 small distal spines and simple setae; dactylus with several simple setae at base of unguis (Fig. 7C). Pereopod IV long and ambulatory, with many simple spines as figured; in addition, carpus has 1 large distal serrate tridentate seta, and propodus has 1 palmate seta (Fig. 7D). Pereopod VII long and ambulatory, with many simple spines as figured; inferior margin of ischium with rugose surface sculpturing (Fig. 7E). Penes short and small, set somewhat apart near posterior margin of sternite VII (Fig. 7F).

Pleon with minute dorsal tubercles, forming a longitudinal carina on the pleotelson; pleonite 3 widest, laterally encompassing pleonite 4. Pleonite 1 almost entirely covered by pereonite VII (Fig. 3A). Pleopodal rami with PMS as figured (Figs. 8A-E). Pleopod 1: peduncle's medial margin with 5 coupling spines; exopod 1.3 times width of endopod; exopod with short simple seta on proximolateral margin (Fig. 8A). Pleopod 2: peduncle's medial margin with 4 coupling spines, 4 plumose setae, and 3 simple setae; exopod 1.4 times width of endopod; appendix masculina narrows to acute apex, 1.1 times exopod length (Fig. 8B). Pleopod 3: peduncle's medial margin with 3 coupling spines and 4 plumose setae; exopod 1.4 times width of endopod, with short incisions on lateral and medial margins (Fig. 8C). Pleopod 4: peduncle with 3 coupling spines, 2 plumose setae, and 4 simple setae; exopod 1.3 times width of endopod, with short incisions on medial and lateral margins (Fig. 8D). Pleopod 5: peduncle with 1 long simple seta on lateral margin;

exopod 1.2 times width of endopod, with short incisions on medial and lateral margins (Fig. 8E).

Pleotelson subtriangular with 8 apical spines and PMS, lacking tubercles but ornamented with narrow v-shaped ridge, center of "v" depressed slightly lower than rest of pleotelson (Fig. 3A). Uropodal endopod and exopod with spines and PMS; lateral margin of exopod without spines, medial margin with 5 spines, apex without notch but with long, simple setae; lateral margin of endopod with 2 spines, medial margin with 8 spines, apex with small apical notch containing long simple setae (Fig. 8F).

Female.—Similar to male, but with reduced surface sculpturing and with dorsal tubercles confined primarily to posterior pereonites.

Size.—Maximum length to 11.1 mm.

Distribution.—*Anopsilana browni* is an amphi-American species. It has been collected in fresh water (a river in Santa Clara Province, Cuba), brackish water (Sittee River and Salt Creek, Stann Creek District, Belize), and low-salinity mangrove habitats (Gulf of Nicoya, Pacific Costa Rica).

Remarks.—The dorsal sculpturing of specimens of *A. browni* from Costa Rica is less prominent than that of the type series, but otherwise there appear to be no differences. Aside from brief mentions by Bruce (1985, 1986a) and Kensley and Schotte (1989), there are no reports of this species since Van Name's original description. The two specimens we acquired for the present study both came from burrows of *Sphaeroma peruvianum*, a common sphaeromatid borer in tropical eastern Pacific red mangrove trees (Perry 1988, Perry and Brusca 1989). This is the first record of cohabitation by these two species.

Anopsilana oaxaca Carvacho and Haasman, 1984
Figs. 3C, D, 9, 10

Anopsilana oaxaca Carvacho and Haasman, 1984: 16. Bruce 1986a: 219.

Material examined.—(1) Mexico, Guerrero, near Acapulco, Laguna Pie de la Cuesta (Laguna Coyuca), on beach of more westerly of two granitic islands; Sta. H46-249, LACM; 16 Sept. 1946; coll. C. Hubbs; 7 specimens. Clipperton Island (eastern Pacific), "freshwater lagoon" samples: (2) off Calix; USNM Acc. No. 213947, Cat. No. 102239; 1956; coll. C. Limbaugh; 14 specimens. (3) 10°18' N, 109°13' W, 0–1 m in lagoon; Sta. 3, Acc. No. BI80-3, SIO Cat. No. C4799; 17 Mar. 1980; coll. J. Cousteau and S. Luke; approx. 30 specimens. (4) 10°18' N, 109°13' W, reef flat at N. end, intertidal; Sta. 2, Acc. No. BI80-2, SIO Cat. No. C4793; 15 Mar. 1980; coll. J. Cousteau and S. Luke; 1 specimen. (5) SIO Cat. No. C3826, USNM Acc. No. 213947; Oct. 1956; coll. C. Limbaugh; 9 specimens. (6) Sta. 277, USNM Acc. No. 230730; Sept. 1958; coll. C. F. Harbison; approx. 145 specimens. (7) Sta. 225, USNM Acc. No. 230730; Sept. 1958; coll. C. F. Harbison; approx. 113 specimens. (8) Sta. 113, USNM Acc. No. 230730; Sept. 1958; coll. C. F. Harbison; approx. 56 specimens.

Description of male.—Anterior margin of cephalon medially produced into a short rostrum that folds ventrally to meet frontal lamina, appearing truncate in dorsal view; cephalon devoid of tubercles (Figs. 3C, D). Antennules short, extended to middle of pereonite I, bases separated by rostrum, flagellum of 7 to 10 articles (Fig. 9A). Antennae extended to middle of pereonite II, flagellum

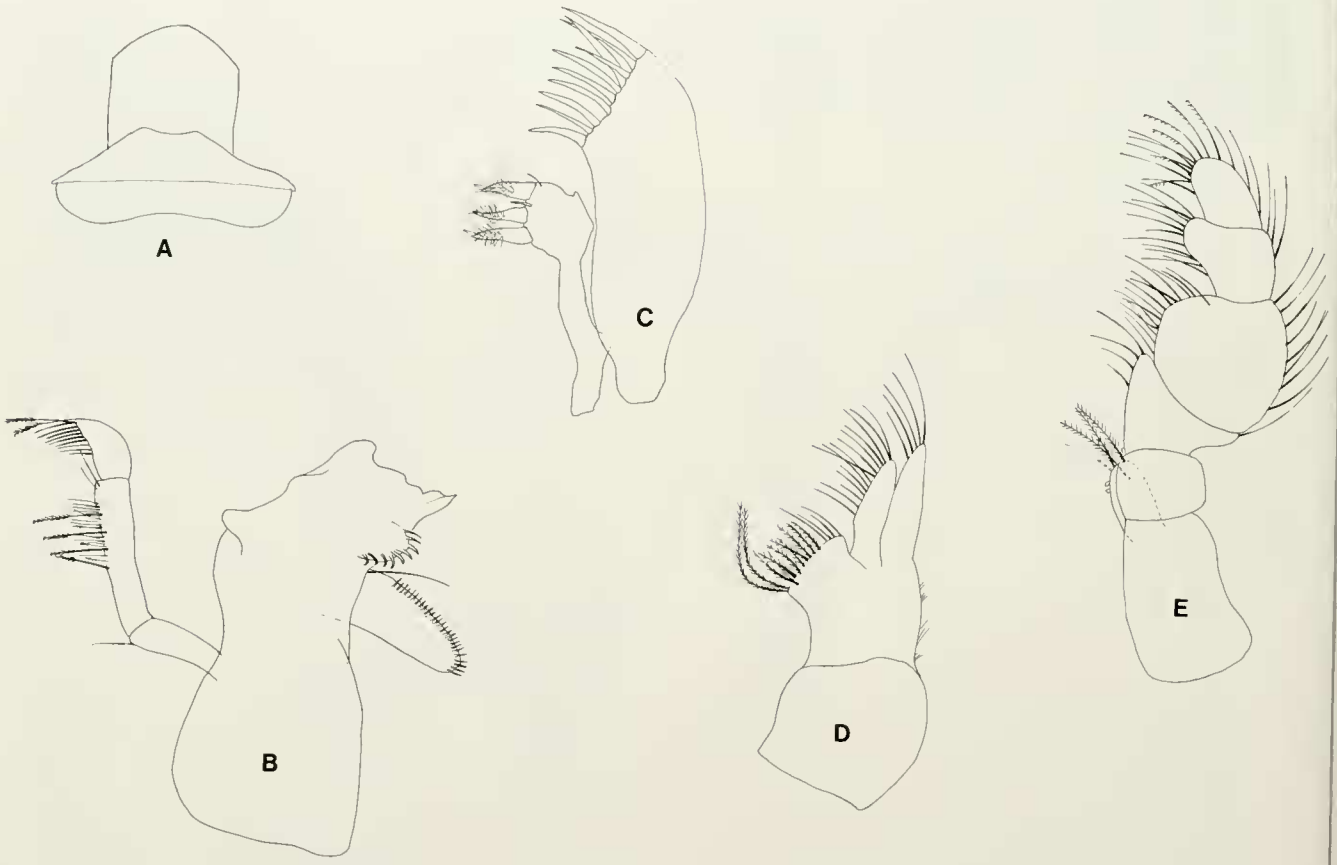

Figure 6. *Anopsilana browni* (SDNHM A.0007), male. A, frontal lamina, clypeus, and labrum. B, mandible (left). C, maxillule (left). D, maxilla (left). E, maxilliped (left).

of 13 to 19 articles (Fig. 9B). Frontal lamina subquadrate; labrum and clypeus subequal in length and width (Fig. 9C). Mandibular spine row with 13 short simple spines; molar process with about 15 small acute spines and many short simple setae; middle palp article with 4 serrate trident setae and about 10 simple setae; distal article with about 11 simple setae and 1 comb seta (Fig. 9D). Maxillule medial lobe with 1 short simple seta; lateral lobe with about 11 stout simple spines, many barbed (Fig. 9E). Maxilla medial lobe with 2 large circumplumose setae, about 10 simple setae, and numerous short subapical hairs; lateral lobes with about 11 and 4 simple setae, respectively; simple subapical seta proximal to base of lateral lobes (Fig. 9F). Maxillipedal palp margins with simple setae as figured; lateral margin of basis with 3 plumose setae, lateral margin of middle article with 1 comb seta; endite short, with 3 coupling spines and 2 apical plumose setae (Fig. 9G).

Pereon devoid of tubercles or carinae (Figs. 3C, D). Posterior angles of coxa VII very acute, produced past anterior margin of pleonite 2; coxae III–VII to V–VII visible in dorsal view. Pereopod I short; superior margin of ischium with 2 simple setae; inferior margin of merus with 5 stout, somewhat blunt spines and 1 simple seta; inferior margin of carpus with 2 simple setae and 1 simple spine; inferior margin of propodus with 3 simple spines and 1 or 2 simple setae; dactylus with 1 small spine and several simple setae at base of unguis (Fig. 10A). Pereopod IV long and ambulatory, with many simple spines as figured (Fig. 10B). Pereopod VII long and ambulatory, with many simple and serrate trident spines as figured (Fig. 10C). Penes short and squat, set close together on posterior margin of sternite VII (Fig. 10D).

Pleon devoid of dorsal tubercles or carinae. Pleonite 3 encompasses pleonite 4 laterally (Figs. 3C, D). Pleopodal rami with

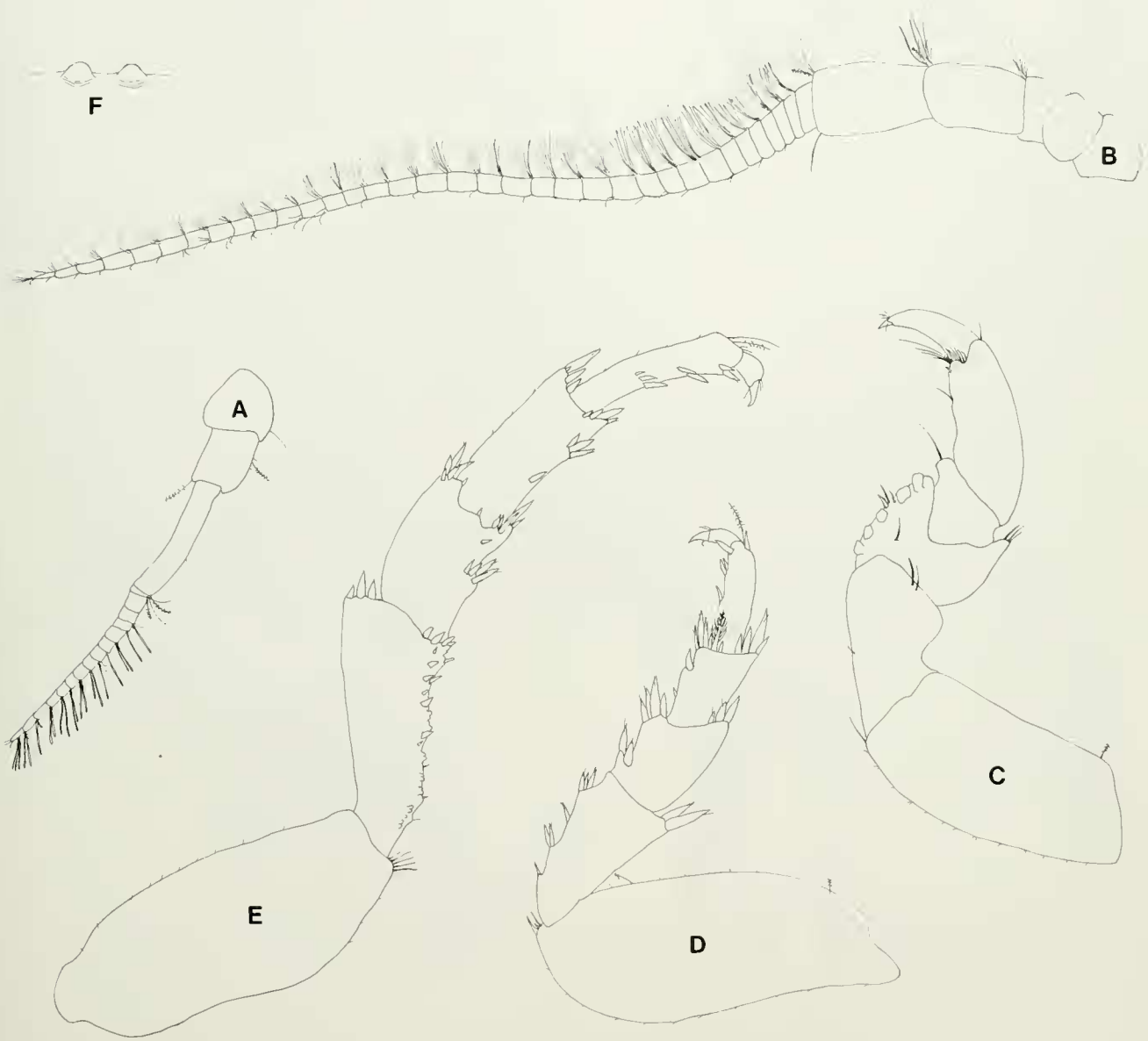

Figure 7. *Anopsilana browni* (SDNHM A.0007), male. A, antennule (left). B, antenna (left). C, pereopod I (left). D, pereopod IV (left). E, pereopod VII (left). F, penes.

PMS as figured (Figs. 10F–J). Pleopod 1: peduncle's medial margin with 3 coupling spines and 2 plumose setae, lateral margin with 1 small simple seta; exopod 1.8 times width of endopod; exopod with a stout 1 simple seta on proximolateral margin (Fig. 10F). Pleopod 2: peduncle's medial margin with 3 coupling spines and 4 plumose setae, lateral margin with 1 small simple spine; exopod 1.6 times as wide as endopod; appendix masculina narrows to acute apex with small barbs, 1.3 times exopod length

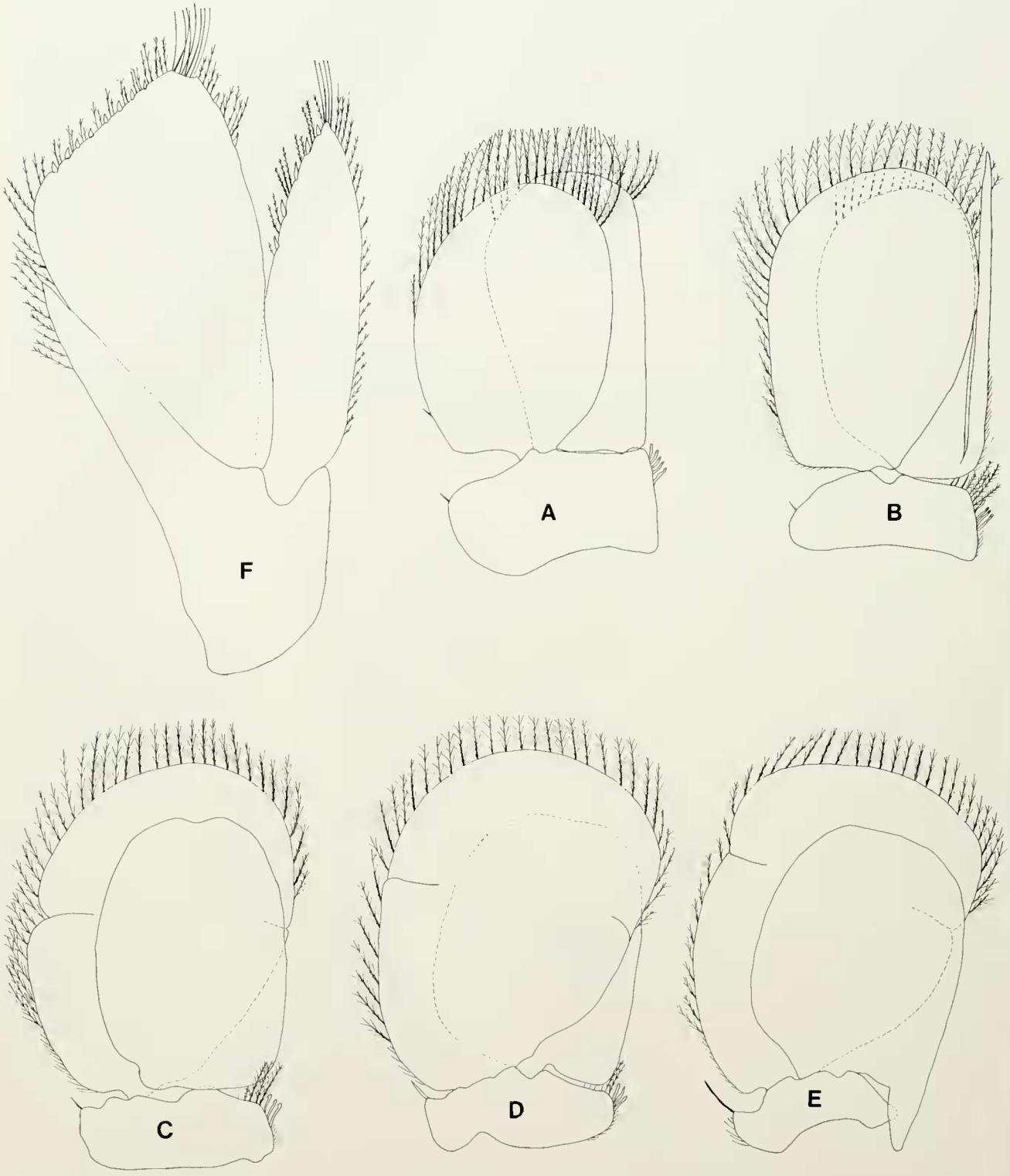

Figure 8. *Anopsilana browni* (SDNHM A.0007), male. A, pleopod 1 (left). B, pleopod 2 (left). C, pleopod 3 (left). D, pleopod 4 (left). E, pleopod 5 (left). F, ventral view of uropod (left).

(Fig. 10G). Pleopod 3: peduncle's medial margin with 3 coupling spines and 4 plumose setae, lateral margin with 1 simple seta; exopod 1.5 times as wide as endopod, with short incisions on lateral and medial margins (Fig. 10H). Pleopod 4: peduncle's medial margin with 3 coupling spines and 4 plumose setae, lateral margin with 1 simple seta; exopod 1.6 times as wide as endopod, with short incisions on medial and lateral margins (Fig. 10I). Pleopod 5: peduncle with 1 long distally plumose seta on lateral margin; exopod 1.4 times width of endopod, with short incisions on medial and lateral margins (Fig. 10J).

Pleotelson subtriangular, lateral margins convex, narrowing to apex; apex with 10–14 marginal simple spines, interspersed with simple setae; dorsum devoid of tubercles or carinae (Figs. 3C, D). Uropods extend beyond pleotelson apex, distally acute; both rami with small apical notch containing long simple setae. Uropodal endopod and exopod with spines and PMS; apex of each ramus with bundle of simple setae set in notch. Uropodal exopod slightly shorter and 0.5 width of endopod (at widest point of each); exopod's medial margin with 3 or 4 stout spines and PMS, lateral margin with 9–11 stout spines, decreasing in size toward base. Uropodal endopod's medial margin with 6 or 7 stout spines interspersed with PMS, lateral margin with 6–8 stout spines and PMS. Uropodal peduncle's lateral margin with 1 small simple spine, medial margin with PMS (Fig. 10E).

Female.—Similar to male, body generally shorter and slightly wider.

Size.—Maximum length 11.5 mm.

Distribution.—A shallow-water species found in brackish intertidal and freshwater habitats; so far known from the states of Oaxaca and Guerrero, Mexico, and from Clipperton Island.

Remarks.—*Anopsilana oaxaca* has been found in brackish mangrove and lagoon habitats in Mexico and in the "freshwater" lagoon inside Clipperton Island, an atoll. In larger individuals, particularly males, the rostral process of the cephalon is slightly larger or more produced (note the difference in Figs. 3C, D). Carvacho and Haasmann (1984) stated that males lack penes; however, short squat penes are present in the adult male specimens we have examined.

The type locality of *Anopsilana oaxaca* is Manialtepec Lagoon, 15 km west of Puerto Escondido, Oaxaca, Mexico. The holotype and allotype are apparently deposited in the collections of the Institute of Biology, Universidad Nacional Autónoma de México (UNAM). Paratypes are located in the reference collection of Centro de Investigación Científica y Educación Superior de Ensenada (CICESE), Baja California, Mexico, and in the Muséum National d'Histoire Naturelle, Paris. Several attempts to borrow type material from UNAM and CICESE met with no success.

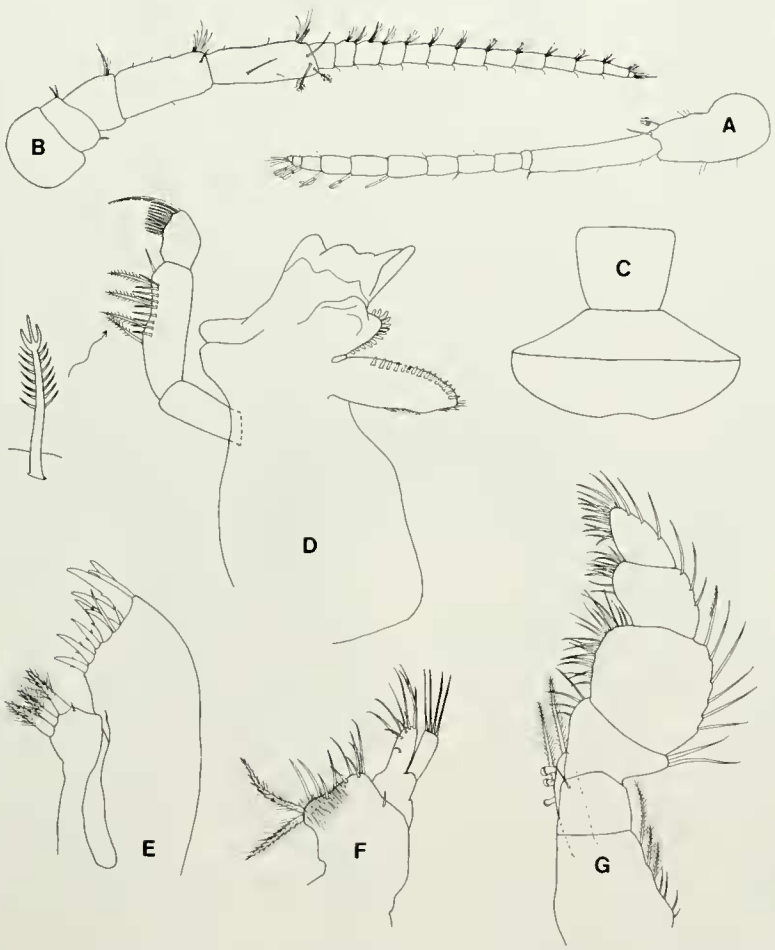

Figure 9. *Anopsilana oaxaca* (SIO C3826), non-oostegial female. A, antennule. B, antenna. C, frontal lamina, clypeus, and labrum. D, mandible (left). E, maxillule. F, maxilla. G, maxilliped.

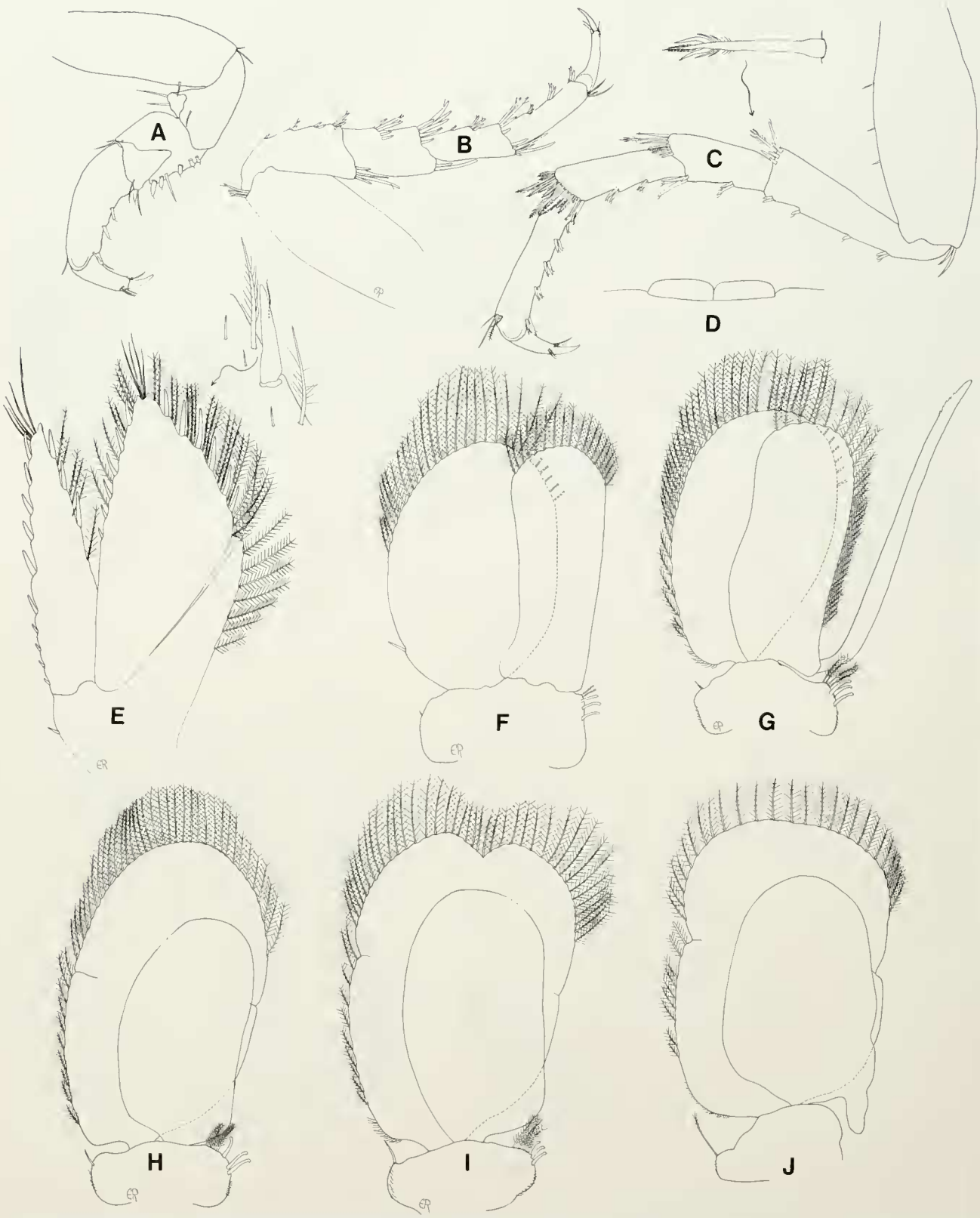

Figure 10. *Anopsilana oaxaca* (USNM 102239), male. A, pereopod I. B, pereopod IV. C, pereopod VII. D, penes. E, dorsal view of uropod; note detail of endopod's medial margin. F, pleopod 1. G, pleopod 2. H, pleopod 3. I, pleopod 4. J, pleopod 5.

Cirolana Leach, 1818

Type species.—*Cirolana cranchii* Leach, 1818, by monotypy. Type material at BMNH. See Bruce and Ellis (1983) for a redescription of *Cirolana cranchii*.

Synonymy.—Emended and subsequent to Bruce (1986a:139).

Cirolana. Sars 1897: 69. Moore 1902: 166. Brusca and Ninos 1978: 379. Brusca 1980: 228. Holdich et al. 1981: 557. Bruce and Bowman 1982: 325. Brusca and Iverson 1985: 35. Delaney 1986: 731. Kensley and Schotte 1987: 227.

Description.—Body 2.5–3.0 times longer than broad, smooth or variously ornamented with tubercles, ridges, carinae, or grooves. Eyes small to moderate sized. Cephalon with rostrum absent or present as a small median point, which may extend ventrally to overlap frontal lamina; posterior region of cephalon often with partial incision lines on lateral margins. Frontal lamina flat, subquadrate to about twice as long as broad, but approaching round or pentagonal in many species; sessile or with anterior margin freely projecting; clypeus flat (sessile), short, and wider than long [Bruce (1981a) noted that the clypeus of *Cirolana furcata* "has two projecting lobes"]; labrum flat, as narrow or narrower than clypeus. Antennular peduncle usually 3-articulate, often 2-articulate by fusion of first 2 articles; articles 1 and 2 do not form right angles to one another (as in *Eurydice*); article 3 longest; relative flagellum length varies with age and body length in many species. Antennal peduncle 5-articulate; articles 1–3 short, 4 and 5 long; articles 4 and 5 combined usually longer than 1–3 combined. Mandible with broad, tridentate incisor, middle cusp often reduced, especially on left mandible; spine row a well-developed rounded lobe with many small simple spines and simple setae; palp 3-articulate, middle article longest, middle and distal articles with setae. Maxillule medial lobe slender, with 3 stout circumplumose spines and sometimes a single minute simple seta; lateral lobe with 10–14 stout simple spines, spines often barbed. Maxilla medial lobe short and truncate, typically with a few large circumplumose setae and many simple and plumose setae; lateral lobe bifurcate, with many apical simple setae. Maxilliped broad, palp 5-articulate, article wider than others; endite often with distal plumose and/or simple setae, usually with 2 coupling spines (rarely 1 or 3).

Pereonite I usually 1.4–1.5 times longer than pereonite II. Coxae II–VII increasing in size posteriorly, becoming larger and often more acute posteriorly. Pereopods generally spinose on inferior and distal superior margins; inferior margin of merus of pereopod I with several blunt spines; pereopods I–III grasping, shorter than IV–VII, with inferior margins of merus and ischium not produced or only modestly produced; pereopods IV–VII long and ambulatory, articles neither markedly flattened nor expanded; all pereopodal dactyli with small, blunt, stout spine at base of unguis. Penes small and knoblike or moderate in size.

Pleon of 5 pleonites. Pleonite 1 often concealed or partly concealed by pereonite VII; pleonite 5 narrower than 1–4, and with lateral margins covered by pleonite 4. Peduncles of pleopods 1–5 broader than long, with coupling spines and plumose setae on medial margin, often without lateral lobes; rami similar, not markedly elongate, endopods usually shorter and narrower than exopods, and with fewer PMS. Pleopods 1 and 2 similar to one another; exopod of pleopod 1 of many species with a prominent simple seta on proximolateral margin; appendix masculina arising basally from endopod of male pleopod 2. Pleopods 3–5 often with partial or complete incisions across exopods. Endopod of pleopod 5 with proximomedial angle produced, lobelike, without PMS; peduncle's medial margin without plumose setae or coupling spines. Pleotelson with or without dorsal tubercles or carinae; apex subacute, rounded or truncate, rarely incised or excavated; usually with marginal spines and PMS. Uropods with inner angle of peduncle strongly produced and acute, apex with or without marginal spines but always with PMS; uropodal rami with or without apical notches; lateral and medial margins with or without spines and PMS.

Remarks.—The genus *Cirolana* was the second genus described in what is now the family Cirolanidae. Although with 84 species it is still the largest genus in the family, many species were transferred to six other genera by Bruce (1981a): *Anopsilana*, *Cartetolana*, *Metacirolana*, *Natatolana*, *Neocirolana*, and *Politolana*.

Bruce (1986a) stated that *Anopsilana* and *Neocirolana* are the genera most closely related to *Cirolana*. Indeed, these 3 genera are extremely similar. So far as we are aware, *Anopsilana* clearly differs from *Cirolana* only in lacking PMS on the endopods of pleopods 3 and 4. *Neocirolana* differs from *Cirolana* in its reduced mandibular incisor and the occasional reduction of the maxilla (the degree of reduction in both mouthparts varies from species to species).

Cirolana is worldwide in distribution, though most species have been described from tropical and subtropical regions, at depths ranging from the intertidal zone to about 200 m. There are several deep-water species, including one (*C. fornicata*) from about 2000 m.

Five species occur in the tropical eastern Pacific: *harfordi*, *diminuta*, *parva*, *nielbrucei* n. sp., and *namelessensis* n. sp. *Eurylana arcuata* (Hale, 1925), a Southern Hemisphere species introduced into San Francisco Bay, California (Bowman et al. 1981), was until recently placed in *Cirolana* but was removed to *Eurylana* by Jansen (1981).

In this study, careful uropod and pleotelson spine counts were made, using both transmitted and reflected light. An effort was made to determine whether setae and spines were broken off or missing by examining the margin of the pleotelson or uropod cuticle for sockets or cuticular fragments. We believe that the ranges of spine counts we specify for the various *Cirolana* species in this study indicate consistent species-specific characters; hence they figure prominently in species discrimination and the key.

World list of species.—

1. *C. albida* Richardson, 1901. Florida.
2. *C. albidoida* Kensley and Schotte, 1987. The Bahamas.
3. *C. arafurae* Bruce, 1986. Kai Islands, Indonesia.
4. *C. argentina* Giambiagi, 1931 [but dated 1930] (should perhaps be transferred to *Excirolana*). Argentina.
5. *C. avida* Nunomura, 1988. Japan.
6. *C. australiensis* Hale, 1925. South Australia.
7. *C. bisulcata* Hobbins and Jones, 1993. Red Sea.
8. *C. bougaardti* Kensley, 1984. South Africa.
9. *C. bovina* Barnard, 1940. South and East Africa to India.
10. *C. brocha* Bruce, 1986. Queensland, Australia.
11. *C. canaliculata* Tattersall, 1921. Off New Zealand.
12. *C. capricornica* Bruce, 1986. Queensland, Australia.
13. *C. carina* Jones, 1976. Kenya.
14. *C. chaloti* Bouvier, 1901. Zaire.
15. *C. cingulata* Barnard, 1920 South Africa.
16. *C. cooma* Bruce, 1986. Queensland, Australia.
17. *C. coronata* Bruce and Jones, 1981. Japan.
18. *C. corrugis* Jones, 1976. Kenya and Red Sea.
19. *C. cranchii* Leach, 1818. Atlantic Ocean and Mediterranean Sea.
20. *C. crenulitelson* Kensley and Schotte, 1987. Belize.
21. *C. curtensis* Bruce, 1986. Queensland, Australia.
22. *C. diminuta* Menzies, 1962. Southern California to Galapagos Islands.
23. *C. epimerias* Richardson, 1910. Philippines.
24. *C. erodiae* Bruce, 1986. Queensland, Australia.
25. *C. fluviatilis* Stebbing, 1902. South Africa.
26. *C. fornicata* (Mezhov, 1981). North-central Pacific Ocean.
27. *C. furcata* Bruce, 1981. New South Wales, Australia.

28. *C. garuwa* Bruce, 1986. Western Australia.
29. *C. halei* Bruce, 1981. New South Wales, Australia.
30. *C. harfordi* (Lockington, 1877). British Columbia to northwestern Mexico; also Australia, Hong Kong, and Japan (probably introduced).
31. *C. hesperia* Bruce, 1986. Western Australia.
32. *C. imposita* Barnard, 1955. South Africa.
33. *C. improceros* Bruce, 1986. Queensland, Australia.
34. *C. incisicauda* Barnard, 1940. South Africa.
35. *C. indica* Nierstrasz, 1931. Indonesia.
36. *C. kendi* Bruce, 1986. Queensland, Australia.
37. *C. kombona* Bruce, 1986. Queensland, Australia.
38. *C. lata* Haswell, 1881 [Bruce (1986a) synonymized *C. lata* var. *integra* Miers, 1884, with *Cartetolana lineata* Potts, 1915, as *Cartetolana intregra* (Miers, 1884)]. New South Wales, Australia.
39. *C. latistylis* Dana, 1853 (*species inquirenda*, see Bruce 1986a). Indo-Pacific.
40. *C. lignicola* Nunomura, 1984. East China Sea.
41. *C. littoralis* Barnard, 1920. South Africa.
42. *C. magdalaina* Bruce, 1980. Australian Coral Sea.
43. *C. manorae* Bruce and Javed, 1987. Northern Indian Ocean.
44. *C. mascarenensis* Müller, 1991. Réunion Island, Indian Ocean.
45. *C. meinerti* Barnard, 1920. South Africa.
46. *C. mekista* Bruce, 1986. Queensland, Australia.
47. *C. meseda* Hobbins and Jones, 1993. Red Sea.
48. *C. minuta* Hansen, 1890. West Indies.
49. *C. morilla* Bruce, 1986. Queensland, Australia.
50. *C. namelessensis* n. sp. Galapagos Islands, Ecuador.
51. *C. nielbrucei* n. sp. Gulf of California, Mexico.
52. *C. obtruncata* Richardson, 1901. Caribbean.
53. *C. oreonota* Bruce, 1986. Torres Strait, Australia.
54. *C. palifrons* Barnard, 1920. South Africa.
55. *C. paraerodiae* Müller and Salvat, 1993. French Polynesia.
56. *C. parva* Hansen, 1890. Tropical amphi-American.
57. *C. perlata* Barnard, 1936. Burma.
58. *C. pleonastica* Stebbing, 1900. Solomon Islands, West Pacific.
59. *C. porcellana* Barnard, 1936 (*incertae sedis*, see Bruce 1986a). Burma.
60. *C. portula* Bruce, 1986. Victoria, Australia.
61. *C. quadripustulata* Hurley, 1957. (*incertae sedis*, see Bruce 1986a). New Zealand.
62. *C. rugicauda* Heller, 1861. South Africa and southern Indian Ocean.
63. *C. sadoensis* Nunomura, 1981. Japan.
64. *C. saldanhae* Barnard, 1951. South Africa.
65. *C. schioedtei* Miers, 1884 (*incertae sedis*, see Bruce 1986a). Australia and Arafura Sea.
66. *C. similis* Bruce, 1981. New South Wales, Australia.
67. *C. solitaria* Bruce, 1986. New South Wales, Australia.
68. *C.* sp. Bruce, 1986. (*incertae sedis*, see Bruce 1986a). Australia.
69. *C. stebbingi* Nierstrasz, 1931 (*incertae sedis*, see Bruce 1986a). Indonesia.
70. *C. stenoura* Bruce, 1986. Lizard Island, Australia.
71. *C. sulcata* Hansen, 1890. South Africa.
72. *C. sulcaticauda* Stebbing, 1904. East Africa to India and Sri Lanka.
73. *C. theleceps* Barnard, 1940. South Africa and Red Sea.
74. *C. transcostata* Barnard, 1959. South Africa.
75. *C. triloba* Bruce, 1981. Australia.
76. *C. tuberculata* (Richardson, 1910). Philippines.
77. *C. tuberculosa* Bruce, 1986. Queensland, Australia.
78. *C. tumulosa* Holdich, Harrison, and Bruce, 1981. Queensland, Australia.
79. *C. undulata* Barnard, 1914. South Africa.
80. *C. urostylis* Menzies, 1962 (*incertae sedis*, see Bruce 1986a). Chile.
81. *C. vanhoffeni* Nierstrasz, 1931. Indonesia.
82. *C. venusticauda* Stebbing, 1902. South Africa.
83. *C. vicina* Barnard, 1914. South Africa.
84. *C. victoriae* Bruce, 1981. Victoria, Australia.

Key to Tropical Eastern Pacific *Cirolana* Species

1. Uropodal rami without apical notch; pleotelson margin with 8–36 spines (in large males, pleotelson with 2 large dorsal tubercles and pleonite 5 with 2 mediodorsal tubercles); merus of pereopod 1 with 6 stout blunt spines on inferior margin; rostrum meets but does not overlap frontal lamina; mandibular palp article 3 with distinctly excavated or scoop-shaped comb setae; antennular peduncle articles 1 and 2 free, not fused ..... *C. harfordi*
— Both uropodal rami with apical notch; pleotelson margin with 6–10 spines (with or without dorsal tubercles); merus of pereopod 1 usually with fewer than 6 stout blunt spines on inferior margin; rostrum overlaps frontal lamina; mandibular palp article 3 with simple comb setae; antennular peduncle articles 1 and 2 entirely or largely fused 2
2. Pleonites 3–5 each with a pair of submedian dorsal tubercles; pleotelson with 2 submedian rows of tubercles; labrum approximately 3 times as long as clypeus ..... *C. namelessensis* n. sp.
— Pleonites 3–5 without submedian dorsal tubercles; pleotelson smooth, devoid of tubercles; labrum and clypeus subequal in length 3
3. Pleotelson margin with 6–7 spines; inferior margin of propodus of pereopod 1 tuberculate; pleopod 1 with lateral margin of endopod strongly concave; pleopod 2 endopod markedly shorter than exopod ..... *C. nielbrucei* n. sp.
— Pleotelson margin with 8–9 spines; inferior margin of propodus of pereopod 1 not tuberculate; pleopod 1 with lateral margin of endopod not concave or only weakly concave; pleopod 2 endopod and exopod subequal in length 4
4. Maxillipedal endite reaches only to first palp article; appendix masculina acute, often with filamentous apex; penes moderate in size, set close together in line with medial margins of pleopod 1 peduncle ..... *C. parva*
— Maxillipedal endite reaches second palp article; appendix masculina bluntly round to subacute; penes small, set apart in line with middle of pleopod 1 peduncle ..... *C. diminuta*

Cirolana diminuta Menzies, 1962
Figs. 11A, B, 13-17

Cirolana diminuta Menzies, 1962b: 343. Schultz 1969: 184. Bowman 1977: 653 (as *C. parva*). Brusca 1980: 228. Bruce and Bowman 1982: 327. Brusca and Iverson 1985: 35. Stepien and Brusca 1985: 91. Bruce 1986a: 220.

Type material examined.—(1) Holotype (USNM 108647): Mexico, Baja California, San Quintín Bay, on gray sandy silt with shell fragments and clay, depth less than 7 m; Sta. SQ 13, USNM Acc. No. 245146; 22 Apr. 1960; coll. R. J. Menzies; 1 postmanca. Paratypes (all from San Quintín Bay; coll. R. J. Menzies; 1960–1961): (2) Sta. SQ 181, intertidal; USNM No. 109271, USNM Acc. No. 245146; 10 specimens. (3) Sta. SQ 175, intertidal; USNM 109271, USNM Acc. No. 245146; 40 specimens. (4) Sta. SQ 177, intertidal; USNM 109265, USNM Acc. No. 245146; 1 specimen. (5) Sta. SQ 28, from dark gray silt and worm tubes, at 6–8 m; 23 Apr. 1960; USNM 109269; 2 specimens. (6) SQ Hubbs trawl; USNM 109264, USNM Acc. No. 245146; 2 specimens. (7) Sta. SQ 179, intertidal; USNM 109270, USNM Acc. No. 245146; 3 specimens. (8) Sta. SQ 178, intertidal; USNM 109268, USNM Acc. No.

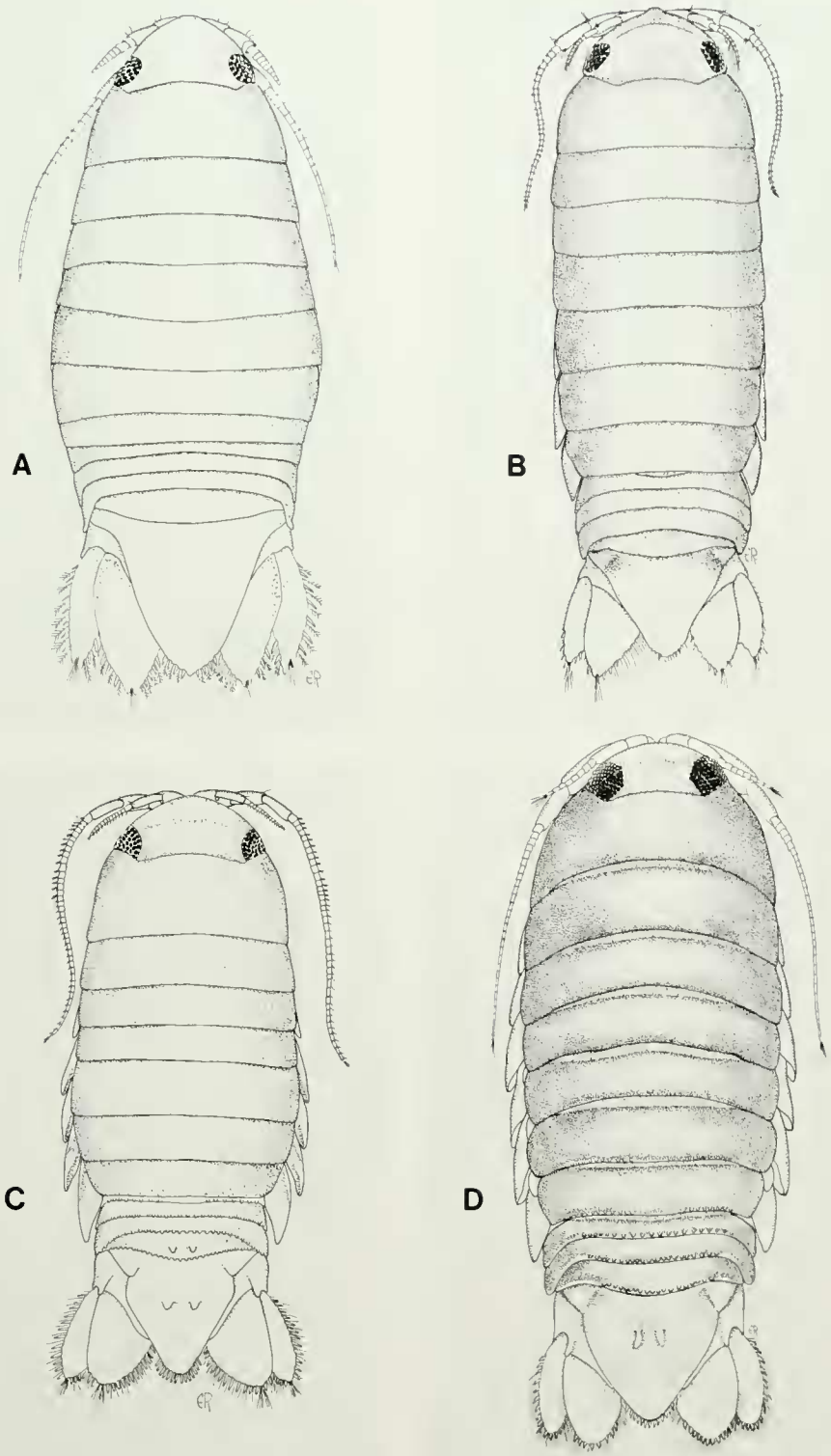

Figure 11. *Cirolana* of the tropical eastern Pacific, dorsal views: A, *C. diminuta* (USNM 108647), holotype, postmanca. B, *C. diminuta* (AHF, Sta. SQ 181), paratype, male. C, *C. harfordi* (BMNH 1878:9), probable syntype, male. D, *C. harfordi* (SIO C1856), male.

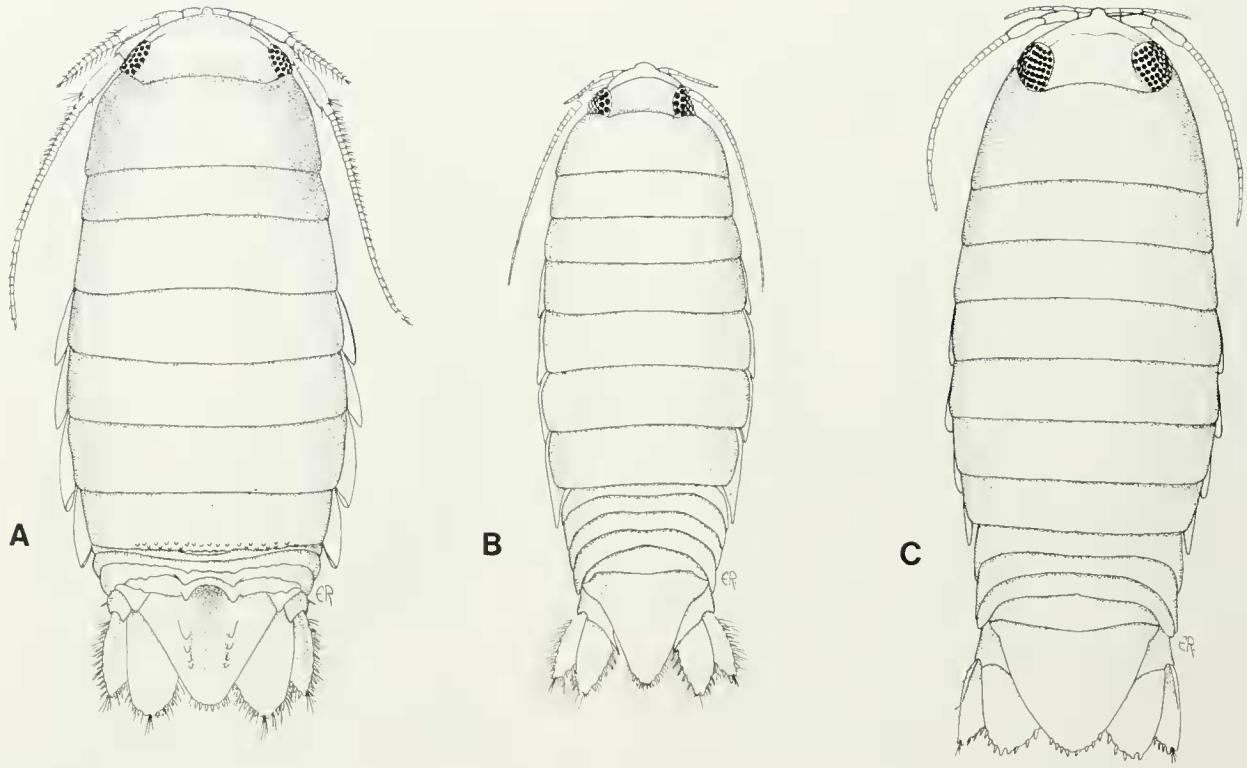

Figure 12. *Cirolana* of the tropical eastern Pacific, dorsal views, continued: A, *C. namelessensis* n. sp. (USNM 252734), holotype, male. B, *C. nielbrucei* n. sp. (LACM), paratype, male. C, *C. parva* (ZMUC), syntype, male.

245146; 10 specimens. (9) (LACM/AHF) Sta. SQ 181, intertidal; Menzies Cat. No. 67; 30+ specimens. (10) USNM 109266; intertidal; 2 specimens.

Other material examined.—California specimens: (11) Santa Barbara Co., Point Conception Light, 34° N, 120° W; R/V *Velero IV* Sta. No. 4822-57, AHF Cat. No. 548-1; 17 Jan. 1957; 3 specimens; (12) Santa Barbara Co., Santa Cruz Island, Smuggler's Cove, night light; R/V *Velero IV* Sta. No. 1660-48, AHF Cat. No. 517-2; 29 Dec. 1948; 1 male; (13) Los Angeles Co., Santa Catalina Island, Farnsworth Bank; AHF Acc. No. 1971-3; 1–2 June 1970; coll. C. Gage and K. Hooker; 10 specimens; (14) San Diego Co., La Jolla, from kelp bed at 16 m; SIO C3821; 2 Dec. 1958 and 13 Mar. 1959; 25+ specimens; (15) San Diego Co., La Jolla, from kelp bed; AHF 957-1; 8 specimens; (16) San Diego Co., off Point Loma, from kelp holdfast, ca. 80 feet; SDNHM; 9 Sept. 1990; coll. C. Gramlich; 20+ specimens.

Pacific Baja California specimens: (17) Cedros Island, south bay, reef and tidepool; R/V *Velero IV* Sta. 2035-51; 19 Apr. 1951; 1 specimen; (18) Scammon's Lagoon, from rock at 5–8 m; Sta. KG-3; 13 Sept. 1953; coll. "K. G."; 1 male; (19) Thurloe Bay, off Thurloe Point, 18 m; Sta. 283, USNM Acc. No. 128938; 9 Mar. 1934; 2 specimens; (20) Abrejos Point; AHF Cat. No. 777-1; 2 damaged specimens; (21) Abrejos Point Estero, mid-intertidal of mangrove lagoon, in filamentous green algae; Sta. "ECCE" MEPA-16C, SIO C1782, SIO Acc. No. BI 175-29; 26 July 1975; coll. Hemingway and Luke; 1 specimen; (22) San Ignacio Lagoon, North Whale Island, 3.25–3.75 m; Sta. H50-71, AHF 956-1; 11 Feb. 1950; coll. Hubbs, Johnson, and Allanson; 2 males; (23) San Ignacio Lagoon; AHF 956-1; 2 males; (24) San Ignacio Lagoon, rocky intertidal, 26°45' N, 113°12' W; SIO Acc. No. BI 76-5, SIO C2477; Mar. 1976; coll. S. Luke; 1 female and 1 juvenile.

Gulf of California specimens (all from Baja California Sur): (25) Espiritu Santo Island, San Lorenzo Channel, from corallines at 43 m; USNM Acc. No. 139772, R/V *Velero III* Sta. 607-36; 21 Mar. 1936; 1 specimen; (26) Espiritu Santo Island, S. San Lorenzo Channel, from coralline algae at 9-27 m; R/V *Velero III* Sta. 498-36, USNM Acc. No. 139772; 19 Feb. 1936; 2 females; (27) Espiritu Santo Island, off Ballenas Bay, 14 m; #643, USNM Acc. No. 144492; 8 Mar. 1937; 1 female; (28) El Bajo, near Loreto, "from formalin wash of *Halimeda* sp."; EWI-2; 20 Aug. 1980, LACM; coll. E. W. Iverson; 1 specimen.

Description of male.—Cephalon without tubercles, with or without interocular furrow (Figs. 11A, B). Small rostral process folding ventrally to separate antennules and partly overlap frontal lamina (Figs. 13A, B, C, 14C). Antennules short, reaching just to, or beyond, posterior margin of cephalon; peduncle with simple and palmate setae and groups of minute spinelets, peduncular articles 1 and 2 fused; flagellum of 9–12 articles, distal articles with aesthetases (Fig. 14A). Antennae reaching posterior margin of pereonite III or IV, with simple and palmate setae as figured; flagellum of 16–29 articles (Fig. 14B). Frontal lamina short and pentagonal (Figs. 13A, B, 14C). Mandibular spine row forms large lobe with comblike row of 12 long fleshy spines and 2 small simple spines above and 6 long simple spines below fleshy spines; molar process with about 24 small acute marginal spines and many small simple setae on posterior margin; middle article of mandibular palp with serrate and simple setae, distal article with about 22 setae of which 18 are simple and the 4 most distal are comb (Fig. 14D). Maxillule medial lobe as figured; lateral lobe with about 12 stout apical spines, the 5 largest spines armed with small barbs (Fig. 14E). Maxilla medial lobe with about 8 plumose setae and 9 simple setae; lateral lobes with about 14 and 5 simple setae, respectively (Fig. 14F). Maxillipedal endite very short, with 1 or 2 coupling spines, small proximal lobe, and about 5 distal circumplumose setae; palp with simple and comb setae as figured (Fig. 14G).

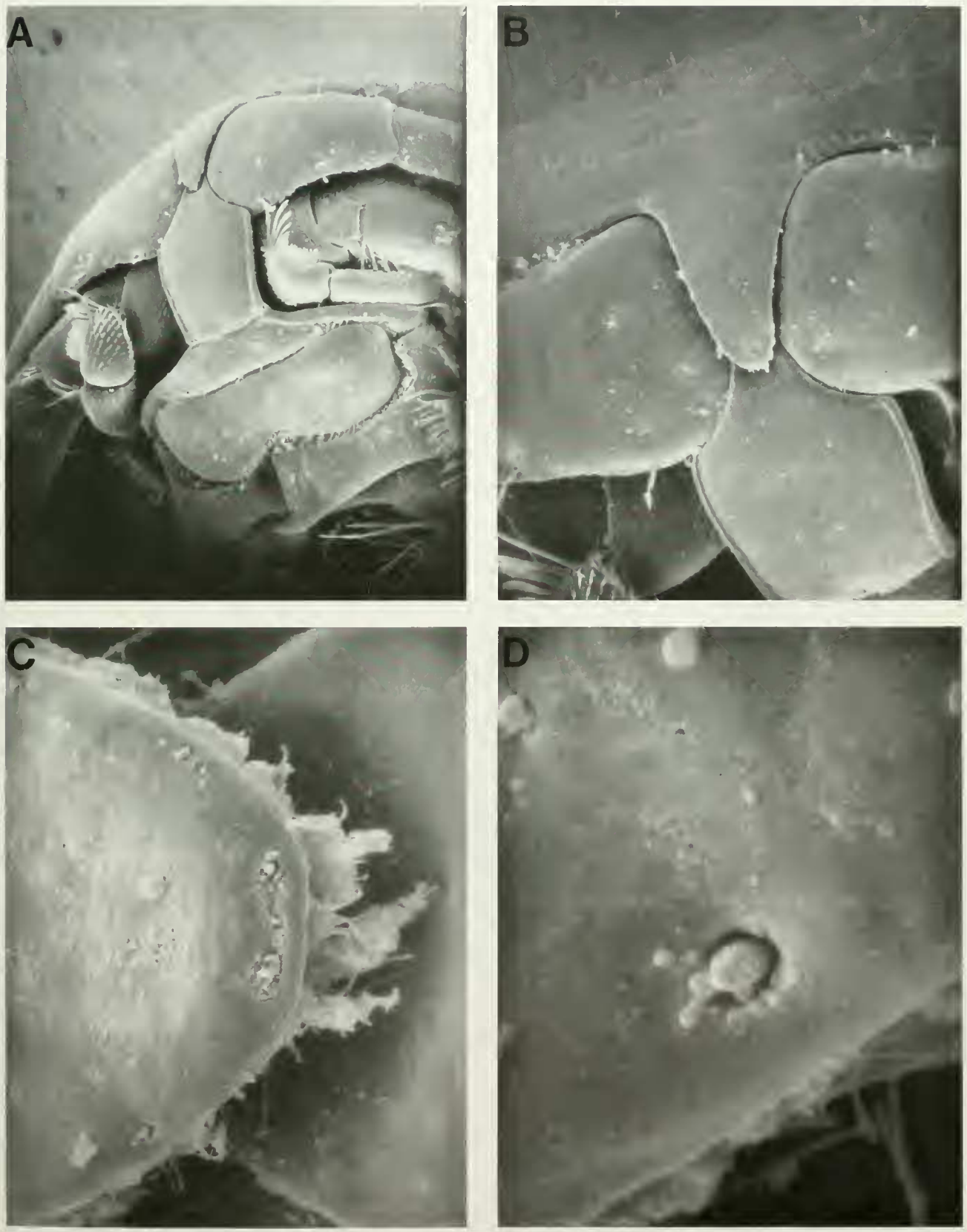

Figure 13. *Cirolana diminuta* (AHF, Sta. SQ 181), paratype, male, scanning electron micrographs: A, frontal lamina, clypeus, and labrum, 120×. B, rostrum and frontal lamina (note overlap of frontal lamina by rostrum), 240×. C, distal margin of rostrum, 1800×. D, seta in pit on distal margin of rostrum, 9000×.

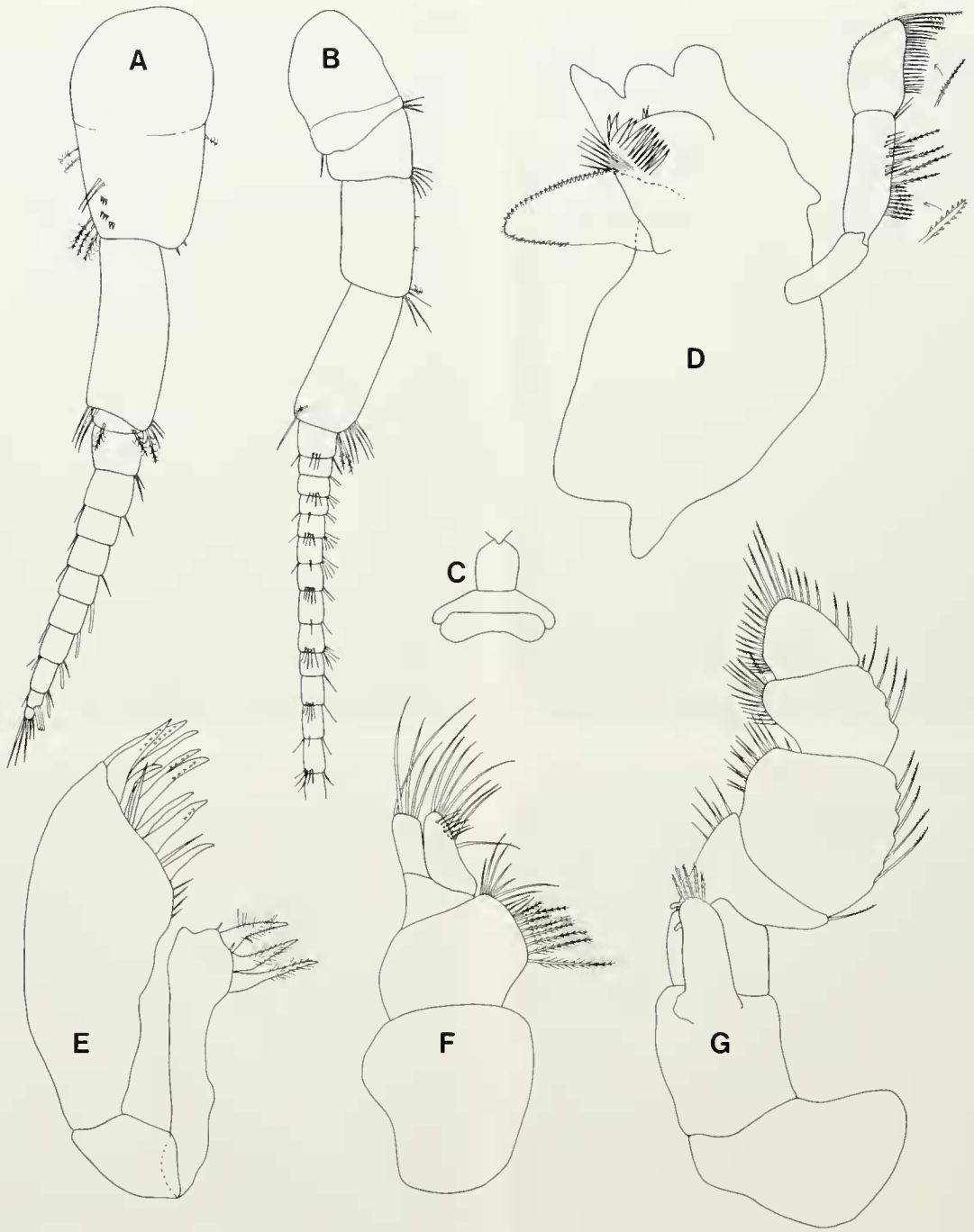

Figure 14. *Cirolana diminuta* (AHF, Sta. SQ 181), paratype, male: A, antennule. B, antenna. C, frontal lamina, clypeus, and labrum. D, mandible. E, maxillule. F, maxilla. G, maxilliped (right).

Pereon widest at pereonites IV and V (Fig. 11A, B). Coxae V–VII visible dorsally. Pereon without dorsal tubercles, carinae, or setae. Pereopod I stout and short, with simple and stout setae; inferior margin of merus with 5 short, blunt spines and several simple setae (Figs. 15A, 16B); dactylus with 1 small spine and 1 simple seta at base of unguis (Figs. 15A, 16A). Pereopod IV with many large spines as figured; dactylus with 1 small spine and 1 simple seta at base of unguis (Fig. 15B). Pereopod VII long, with many large spines as figured (Fig. 15C, 16C); ischium–propodus with long serrate spines and stout, basally denticulate spines, as well as simple spines; dactylus with 1 small spine and 1 long simple seta at base of unguis (Fig. 15C). Penes short, very small, set somewhat apart and in line with middle of peduncles of first pleopods (near posterior margin of sternite VII) (Fig. 15D).

Lateral margins of pleonites 2–4 expanded ventrolaterally; pleon widest at pleonite 2, devoid of dorsal tubercles, carinae, or setae (Figs. 11A, B). Pleopodal rami with PMS as figured (Figs. 15F-J, 16D). Pleopod 1: peduncle's medial margin with 5 long

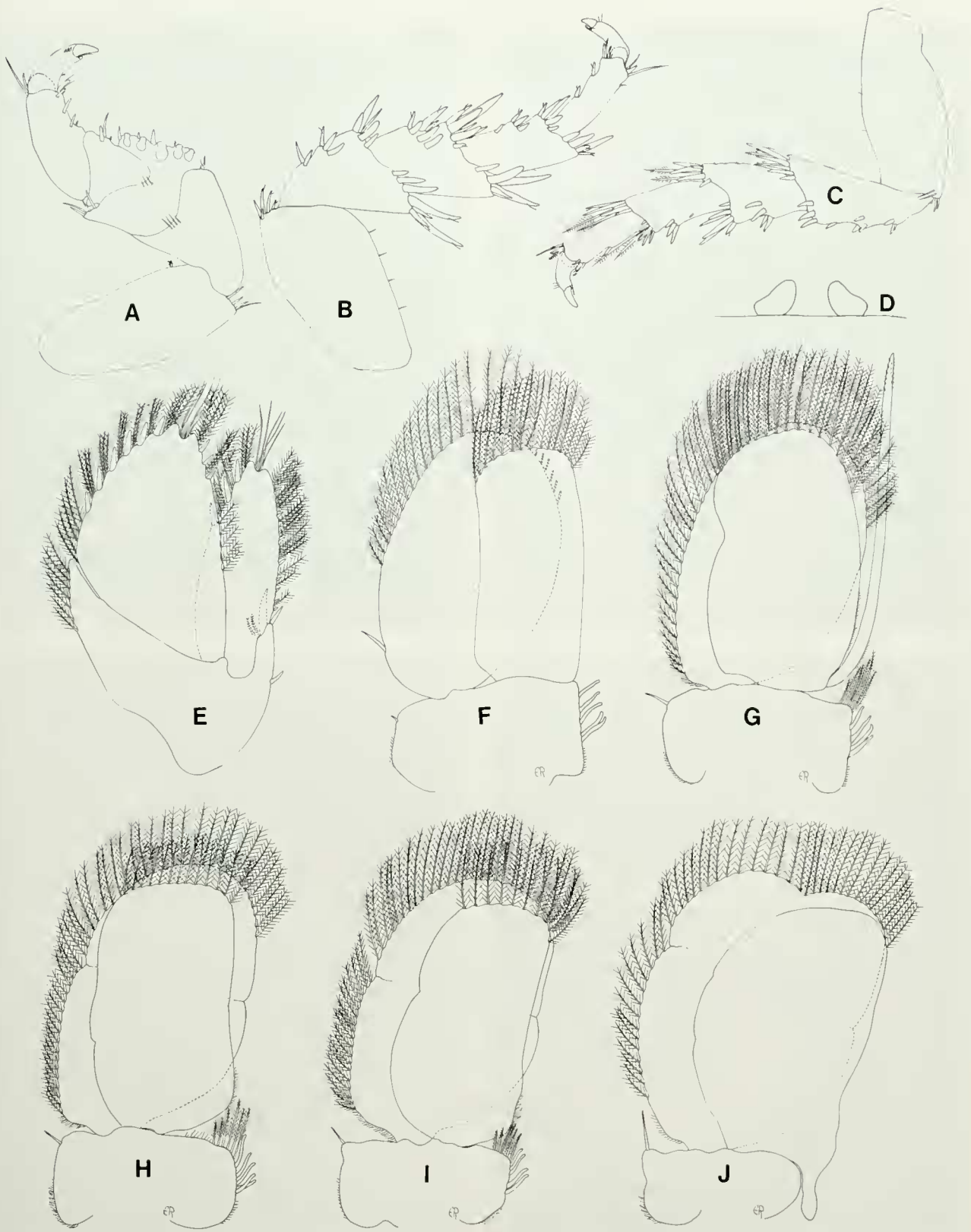

Figure 15. *Cirolana diminuta* (AHF, Sta. SQ 181), paratype, male: A, pereopod I. B, pereopod IV. C, pereopod VII. D, penes. E, uropod. F, pleopod 1. G, pleopod 2. H, pleopod 3. I, pleopod 4. J, pleopod 5.

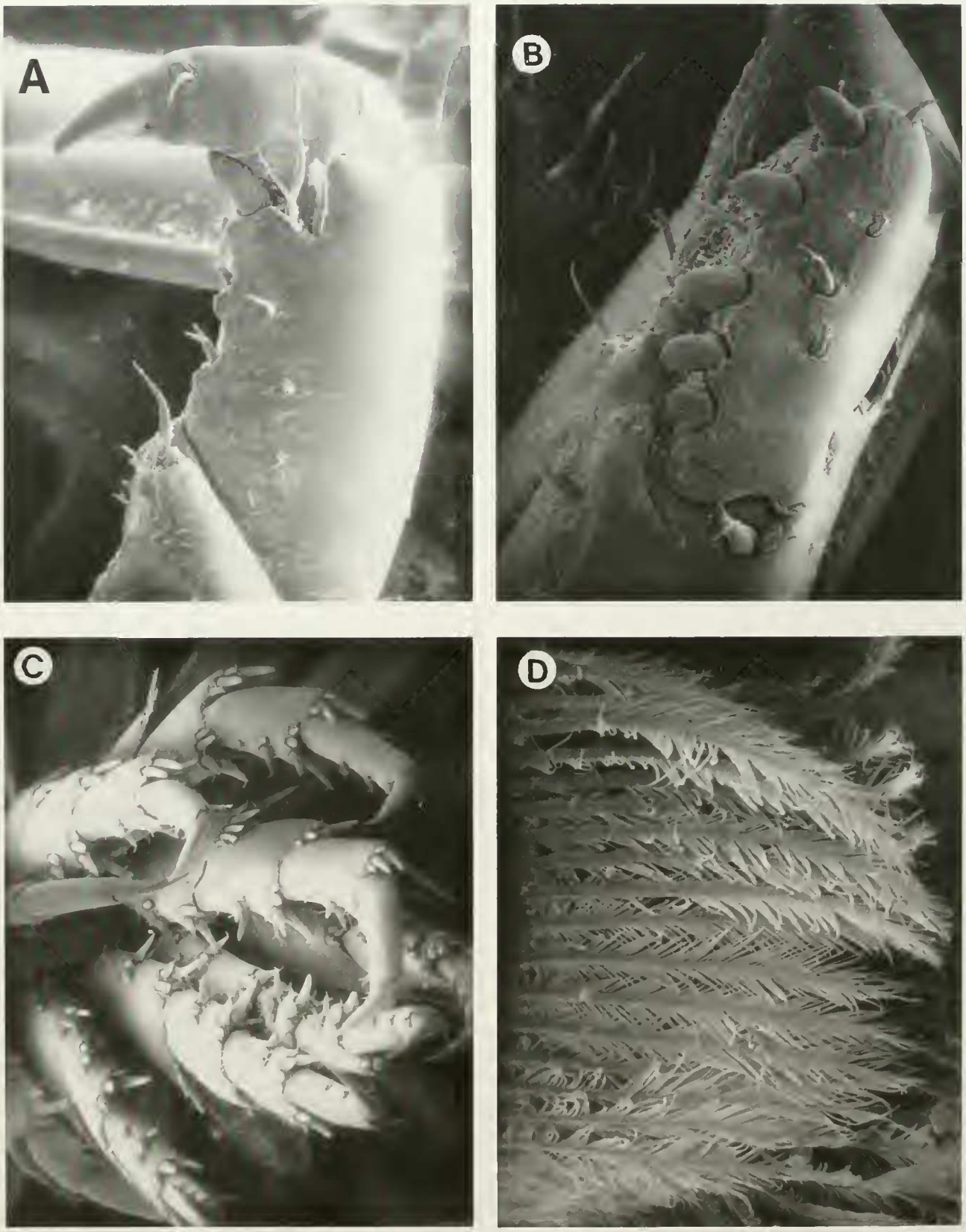

Figure 16. *Cirolana diminuta* (AHF, Sta. SQ 181), paratype, male, scanning electron micrographs: A, distal portion of pereopod I, 240×. B, marginal spines on merus of pereopod I, 120×. C, ventral view of spines on posterior pereopods, 60×. D, ventral view of PMS on pleopod 1, 240×.

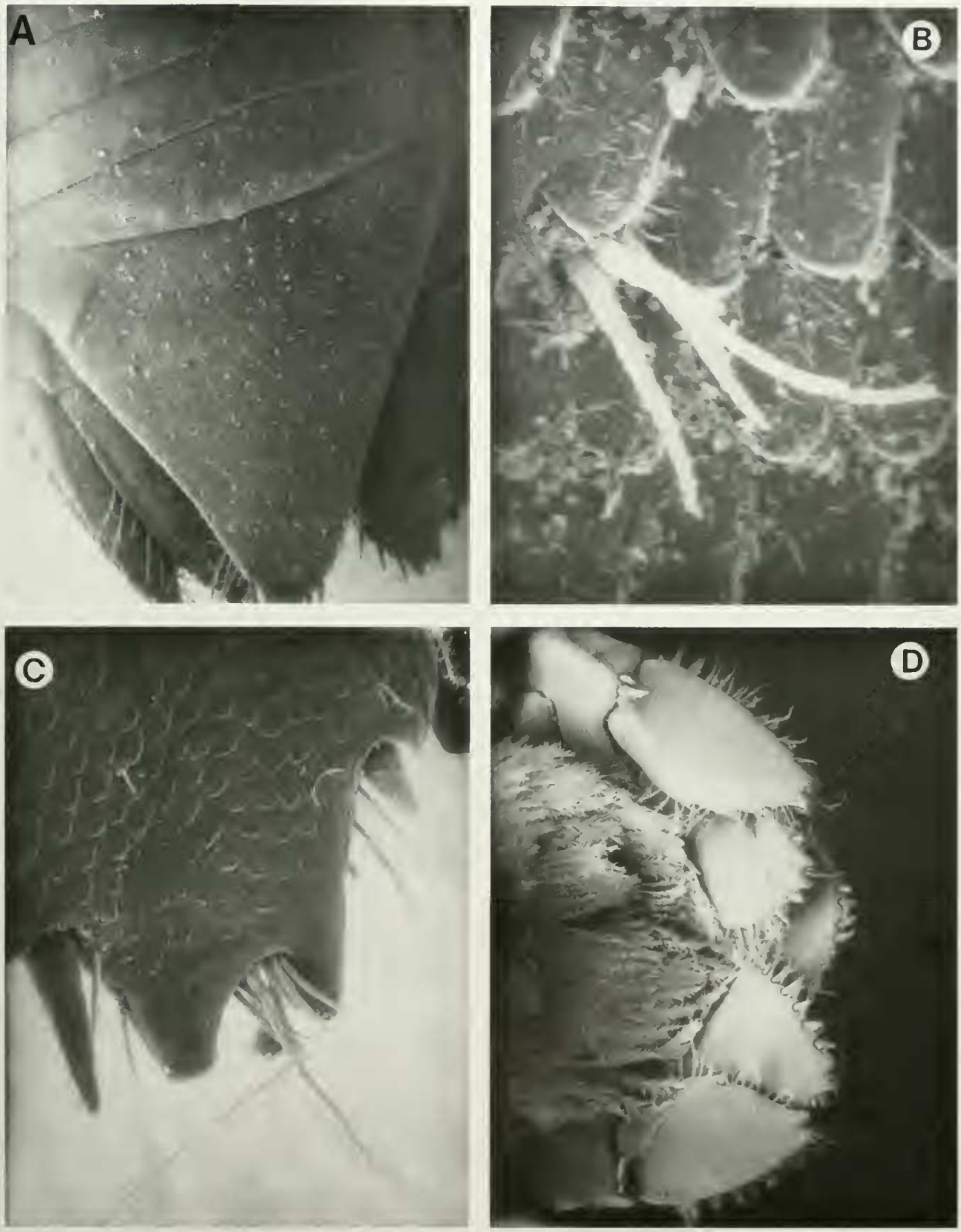

Figure 17. *Cirolana diminuta* (AHF, Sta. SQ 181), paratype, male, scanning electron micrographs: A, pleotelson (note straight lateral margins and dorsal setae), 60×. B, dorsal setae of pleotelson (note scalelike appearance of cuticle in background), 3000×. C, terminal notch on uropodal endopod, 420×. D, ventral view of pleotelson and uropods, 60×.

coupling spines, lateral margin with 1 small simple seta; endopod 0.6 times as wide as exopod, lateral margin slightly concave; exopod with 1 stout spine on proximolateral margin (Fig. 15F). Pleopod 2: peduncle's medial margin with 4–5 coupling spines and 6 plumose setae, lateral margin with 1 simple spine; appendix masculina 1.3 times as long as exopod, apex broadly rounded or occasionally subacute, but never with threadlike extension; appendix masculina with short stout distal setae on margins and occasionally on medial surface as well (Fig. 15G). Pleopod 3: peduncle's medial margin with 5 coupling spines and 6 plumose setae, lateral margin with 1 simple spine; exopod with complete or partial marginal incisions (Fig. 15H). Pleopod 4: peduncle's medial margin with 4 coupling spines and 6 plumose setae, lateral margin with 1 simple spine; exopod with incomplete marginal incisions (Fig. 15I). Pleopod 5: peduncle with 1 simple spine on lateral margin; exopod with incomplete marginal incisions (Fig. 15J).

Pleotelson triangular, narrowing strongly near rounded apex, lateral margins straight or slightly concave (Fig. 17A); apex usually with 8 stout spines, occasionally 9, interspersed with numerous PMS (Fig. 11A); dorsum with scattered simple setae (Figs. 17A, B). Uropodal exopod extends beyond pleotelson (Fig. 17D), not rounded distally as in *C. harfordi*, and more narrow than in *C. harfordi*; both rami with large apical notch, long slender setae arising from each notch (Fig. 17C). Both uropodal rami with spines and PMS on medial and lateral margins. Uropodal exopod 0.5 as wide as endopod and slightly shorter; medial margin with 3 stout spines, lateral margin with 7 or 8 stout spines interspersed with numerous PMS. Uropodal endopod's medial margin with 5–7 stout spines; lateral margin with 2–4 stout spines (Fig. 15E). Uropodal peduncle's medial margin with PMS; lateral margin with 1 medial spine and a group of spines and setae near the articulation of the exopod (Fig. 15E).

Female.—Similar to male.

Ultrastructural features.—When viewed with SEM the dorsal surface of this species, like that of many other isopods, has a somewhat imbricated, "shingle roof" appearance due to scalelike cuticular structures, which are also present on the mouthparts, frontal lamina, elypeus, and labrum. In addition, the dorsal surface of the cephalon, pereon, pleon, and pleotelson have many setae arising from small cuticular pits (Figs. 17A, B). The distal part of the cephalic rostrum has peglike cuticular structures or setae arising from pits along the margin (Figs. 13C, D).

Size.—To maximum length of 10.5 mm.

Distribution.—*Cirolana diminuta* ranges from southern California (Point Conception, Santa Barbara Co.) south along the west coast of Baja California and into the central and southern Gulf of California. It is a littoral and shallow subtidal species, occurring in deeper water (to 43 m) in the warm southern extent of its range.

Remarks.—Menzies' (1962b) described *C. diminuta* as the most abundant and widespread isopod in San Quintín Bay (the type locality). His designated holotype specimen is a postmanca (noted in his text as "young") and is undissected, so the original illustrations and descriptions of mouthparts must have been from a paratype specimen; there are no descriptions of the pereopods and pleopods in the original text. *Cirolana diminuta* and *C. parva* Hansen, 1890, are very similar and difficult to distinguish. Menzies and Glynn (1968) placed *Cirolana diminuta* as a junior synonym of *C. parva*, stating that the species was circumtropical in distribution. Bruce and Bowman (1982) removed *C. diminuta* from synonymy with *C. parva* without describing precisely how the two could be differentiated. They stated only that the species "can be separated by the differences in the characters figured" and by the "vasa deferentia open[ing] flush with the surface of sternite 7" in *C. diminuta*. None of Bruce and Bowman's figures provides reliable means of distinguishing these two species, and the vasa deferentia do not open flush with sternite in either species but exit through distinct penes.

In both *C. diminuta* and *C. parva* length of the antennae, relative to the body, decreases with increasing body length. In most adults the antennae extend to pereonite III or IV, although in small specimens of *C. parva* they may extend to pereonite V. In both species the margins of the pleotelson may be straight or slightly convex, although *C. diminuta* is straight most of the time and *C. parva* is convex most of the time. In both species the exopod of pleopod 3 may be completely or incompletely divided by lateral sutures, and in both species the endopodal lateral margin of pleopod 1 is slightly concave. A consistent feature distinguishing these two species is the position of the penes. In *C. parva* the penes are moderate in size and set very close together in a line even with the medial margins of the peduncles of the first pleopods; in *C. diminuta* the penes are very small and set farther apart, in line with the middle of the peduncles of the first pleopods. Also, the apex of the appendix masculina of *C. parva* is always acute and often tapers to a filamentous or threadlike extension; in *C. diminuta* the apex of the appendix masculina varies from bluntly rounded to subacute but never has a threadlike or filamentous projection. In both species short stout distal spines may occur on either margin (and more rarely across the medial surface) of the appendix masculina.

Cirolana diminuta belongs to the *C. parva* complex of sibling species *sensu* Bruce and Bowman (1982) and Bruce (1986a). Stafford (1912) described an isopod from sponges at Laguna Beach, California, as *Cirolana harfordi* var. *spongicola*, distinguishing it primarily by the straight lateral margins of the pleotelson and serrate uropodal rami. Stafford did not designate type specimens or their deposition. Her figures and description, including a pleotelson with straight lateral margins and a count of 8 marginal spines on the pleotelson apex, suggest that her specimens were *C. diminuta*. However, without any of Stafford's material to examine, we feel it best not to synonymize *C. diminuta* with *C. harfordi* var. *spongicola*, thus leaving the latter as a *nomen dubium*.

Cirolana diminuta is primarily a shallow subtidal species, living in rocks, sandy silts, and algae to a depth of about 50 m. In some localities it is common in the littoral zone. This species is a member of the California demersal zooplankton community. Stepien and Brusca (1985) recently presented experimental evidence of its nocturnal emergence to prey on epibenthic fishes.

Cirolana harfordi (Lockington, 1877)
Figs. 11C, D, 18-20

Synonymy.—Emended and subsequent to Bruce (1986a:146).

Cirolana harfordi japonica. Nunomura 1985a: 132.

Cirolana harfordi japonica Nunomura, 1981: 46 (*lapsus calami*).

Cirolana harfordi. Miller 1975: 296, 307. Brusca and Ninos 1978: 383. Morris et al. 1980: 538. Ricketts et al. 1985: 49, 229, 533. Bruce 1986b: 549.

Non-*Cirolana harfordi*: *Cirolana harfordi* var. *spongicola* Stafford, 1912; probably synonym of *C. diminuta*.

Type material examined.—(1) Probable syntypes (BMNH Reg. No. 1878:9): U.S.A., California, Santa Rosa Island, under stones, "MT," in muddy places; coll. W. G. N. Harford; 2 males (1 damaged).

Other material examined.—California specimens: (2) San Miguel Island, Harris Point, collected under intertidal rocks; SDNHM; 15 Apr. 1985; coll. T. D. Stebbins; 1 specimen.

Pacific Baja California specimens: (3) Banda Point (ca. 20 mi. S. of Ensenada), under rocks, low tide; SDNHM A.0009; 5 Dec. 1987; coll. R. Wetzer and R. C. Brusca; 9 specimens. (4) 2 mi. S. of Rosarito, shore on rocky reef; R/V *Velero IV* Sta. 1597-47, LACM; 6 Mar. 1947; 1 male. (5) Descanso Point, 7 mi. N. of Halfway House, rocky shore; R/V *Velero IV* Sta. 1594-47, LACM; 3 Mar. 1947; 2 specimens. (6) second headland S. of Descanso Point,

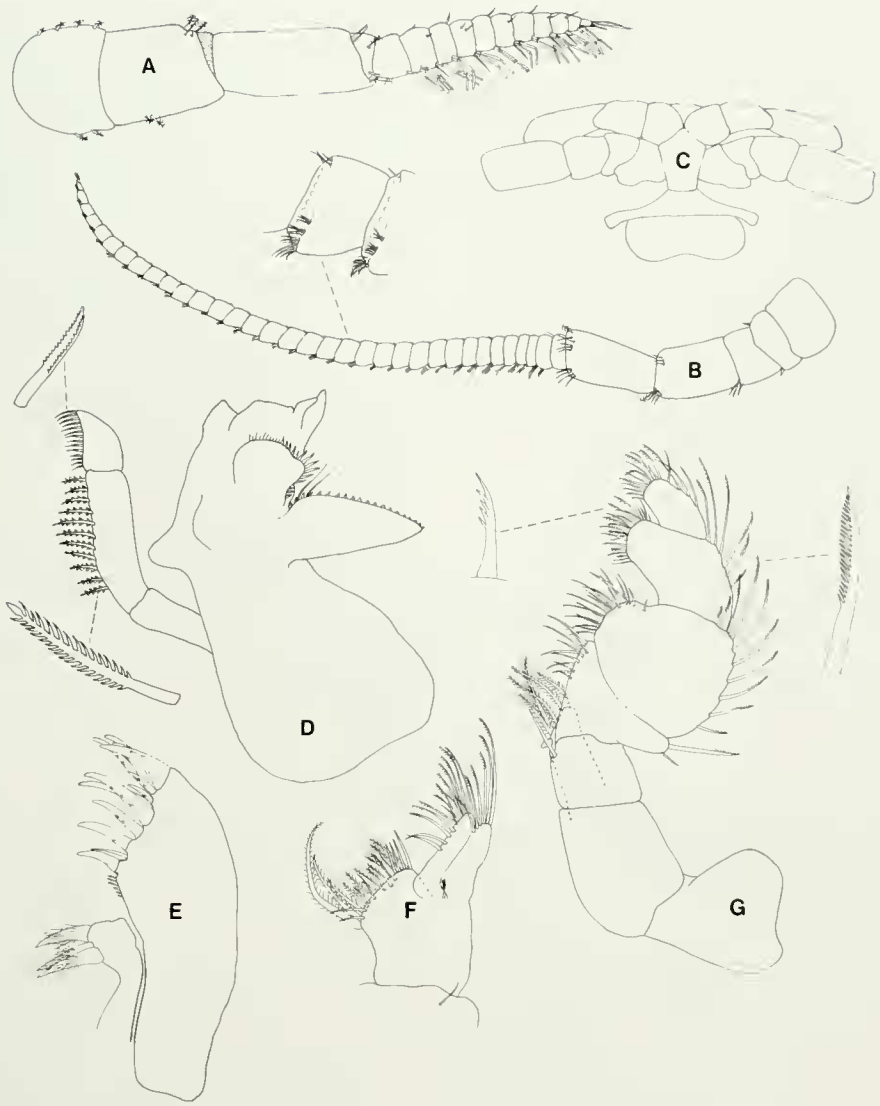

Figure 18. *Cirolana harfordi* (SIO C1856), male: A, antennule (left). B, antenna (left). C, frontal lamina, clypeus, and labrum. D, mandible (left). E, maxillule (left). F, maxilla (left). G, maxilliped (left).

among algae; LACM; 14 Jan. 1946; coll. E. Y. Dawson; 1 female. (7) N. of Descanso Point, within sight of S. Coronado Island, collected on rocky reef, tide –1.2 ft.; R/V *Velero IV* Sta. 1597-47, LACM; 6 Mar. 1947; 11 specimens. (8) Descanso Point, collected on rocky reef, tide –1.2 ft.; LACM; 3 Mar. 1947; 2 specimens. (9) Salsipuedes Point, littoral; SDNHM; 1 Sept. 1976; coll. R. C. Brusca; 4 specimens. (10) Salsipuedes Point, rocky intertidal algae zone; SDNHM; 1 Sept. 1976; coll. R. C. Brusca; 30+ specimens. (11) mouth of Santo Tomas River between San Jose Point and Santo Tomas Point, rocky reef, tide –1.4 ft.; R/V *Velero IV* Sta. 1596-47, LACM; 5 Mar. 1947; 1 adult male and 1 juvenile. (12) San Jose Point; R/V *Velero IV* Sta. 1596-47, LACM; 1 gravid female. (13) Cape Colonet, rocky shore intertidal, 30°57'00" N, 116°17'30" W; R/V *Velero IV* Sta. 1504-46, LACM; 3 specimens. (14) San Ramon Bay, Camalú Point; SDNHM; 19 June 1939; coll. Harbison and Bilderback; 20+ specimens. (15) S. shore of San Ramon Bay, on coast over from Colonia Guerrero, 12 mi. N. of San Quintín Bay, littoral; SDNHM; 4 Aug. 1976; coll. R. C. Brusca and B. Wallerstein; 5 specimens. (16) San Quintín Bay, rocky outcropping in lagoon; R/V *Velero IV* Sta. 2013-51, LACM; 14 Apr. 1951; 1 specimen. (17) San Quintín Bay, intertidal algae and rock washes; SDNHM A.0101; 11 Nov. 1989; coll. R. Wetzer and H. Wetzer; 30+ specimens. (18) Guadalupe Island, Melpomene Cove, 28°52'05" N, 118°19'05" W, algae wash; R/V *Velero IV* Sta. 1912-49, LACM; 17 Dec. 1949; 1 specimen. (19) Guadalupe Island, Melpomene Cove at landing, rock–algae wash; R/V *Velero IV* Sta. 1915-49, LACM; 18 Dec. 1949; coll. R. J. Menzies and D. Reish; 5 specimens. (20) Santa Rosalillita Point, 28°40' N, 114°14' W, rocky intertidal; "ECCE" SR-34, Acc. No. BI 75-39, SIO C1856; 6 Aug. 1975; coll. Luke and Hemingway; 20+ specimens. (21) 2 mi. S. E. of Cedros Island Light, 28°20' N, 115°10' W, 99 m; R/V *Velero III* Sta. 1265-41, LACM; 28 Feb. 1941; 1 specimen. (22) Cedros Island, S. bay, shore collecting; Sta. 28834, USNM Acc. No. 128938; 10 Mar. 1934; 6 specimens. (23) W. side of Middle San Benito Island, 28°18'55" N, 115°34'06" W; R/V *Velero IV*, LACM; 8 May 1950; 1 specimen. (24) W. side of San Benitos Island, 28°18' N, 115°34' W;

R/V *Velero IV* Sta. 1976-50, LACM; 8 May 1950; 7 specimens. (25) Tortugas Bay, 27°41' N, 114°53' W, collected on rocky point via SCUBA, 3–5 m; Sta. "ECCE" BT-23, Acc. No. B175-21, SIO C1755; coll. G. Hemingway and S. Luke; 1 specimen. (26) San Bartolome Point, sulphur rock, 27°37'46" N, 114°52'38" W; R/V *Velero IV* Sta. 2605-54, LACM; 12 Feb. 1954; 10 specimens, including a gravid female. (27) Asuncion Point, 27°08' N, 114°17' W, taken by surface trawl; R/V *Velero IV* Sta. 1950-50, LACM; 28 Apr. 1950; 5 specimens. (28) Magdalena Bay, Entrada Point, 24°32' N, 112°04' W, shore; R/V *Velero IV* Sta. 1961-50, LACM; 2 May 1950; 10+ specimens. No definite locality specified: (29) USNM 86669, Acc. No. 109185; Feb. 1930; coll. E. F. Ricketts; 4 specimens; (30); AHF Acc. No. 1146; Nov. 1947; coll. Dr. Gentry; 1 specimen.

Gulf of California specimens: (31) Mexico, Baja California, La Paz Bay; Dawson Sta. 54, LACM; 10–11 Nov. 1946; coll. E. Y. Dawson; 1 specimen.

Description of male.—Cephalon devoid of tubercles, often with interocular furrow, length about 2.5 times width (Figs. 11C, D). Antennule short, reaching just beyond cephalon; flagellum with 8–12 articles, aesthetascs on most or all articles; middle articles of flagellum broader than long (Fig. 18A). Antenna long, reaching to pereonite IV or V; flagellum with 30–34 articles (Fig. 18B). Frontal lamina pentagonal, broader anteriorly, length approximately 1.5 times width (Fig. 18C). Mandibular spine row with 14 stout simple spines; molar process with about 22 small acute spines and up to 6 long simple setae that arise from proximal region of molar; middle palp article with 22 serrate setae, distal article with 19 comb setae, each hollowed out or excavated (Fig. 18D). Maxillule lateral lobe with 12 stout spines, many barbed, and 6 small subapical spines (Fig. 18E). Maxilla medial lobe with 13 plumose setae and 8 simple setae; lateral lobes with simple and comb setae as figured (Fig. 18F). Maxillipedal endite short, with 1 coupling spine and 5 plumose setae; palp articles with simple and comb setae (Fig. 18G).

Pereon broadest at pereonites IV–V. Posterior margin of pereonites with row of minute tubercles in larger specimens. Coxae

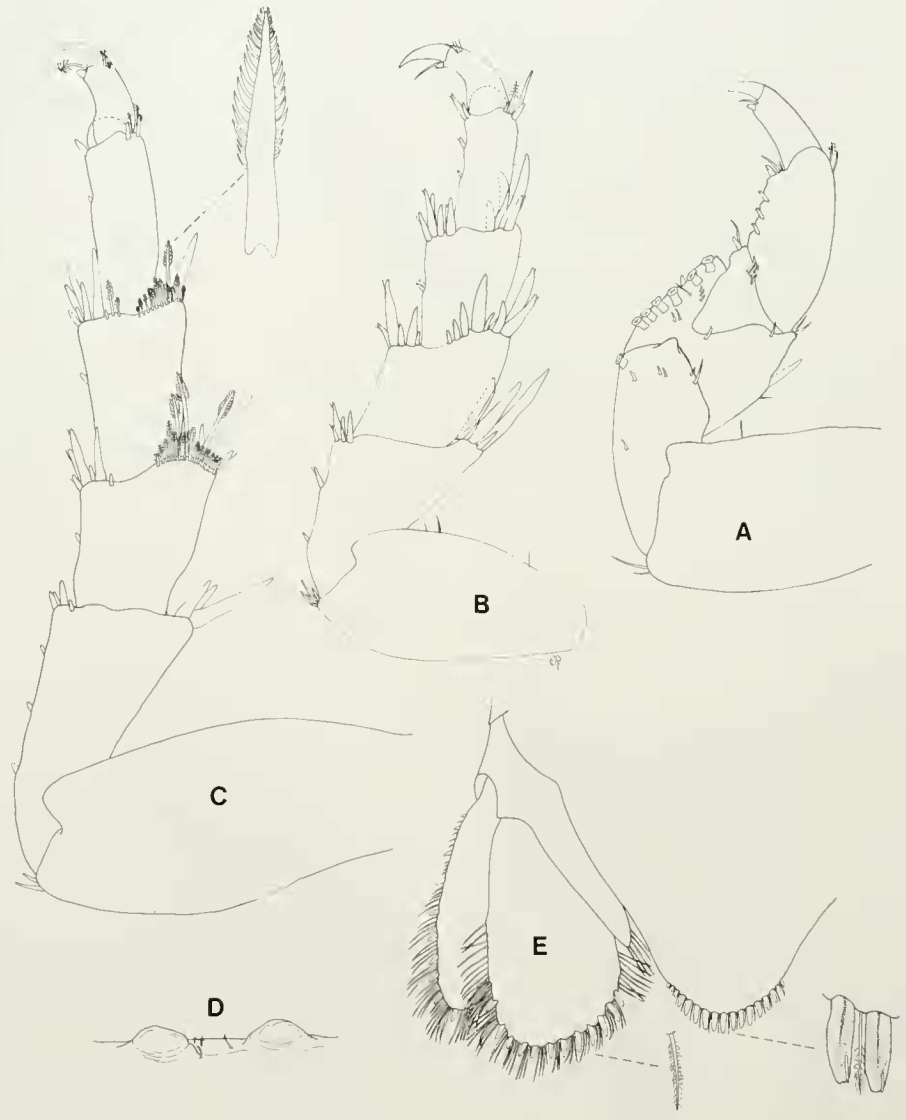

Figure 19. *Cirolana harfordi* (SIO C1856), male: A, pereopod I (left). B, pereopod IV (left). C, pereopod VII (left). D, penes. E, apices of uropod and pleotelson.

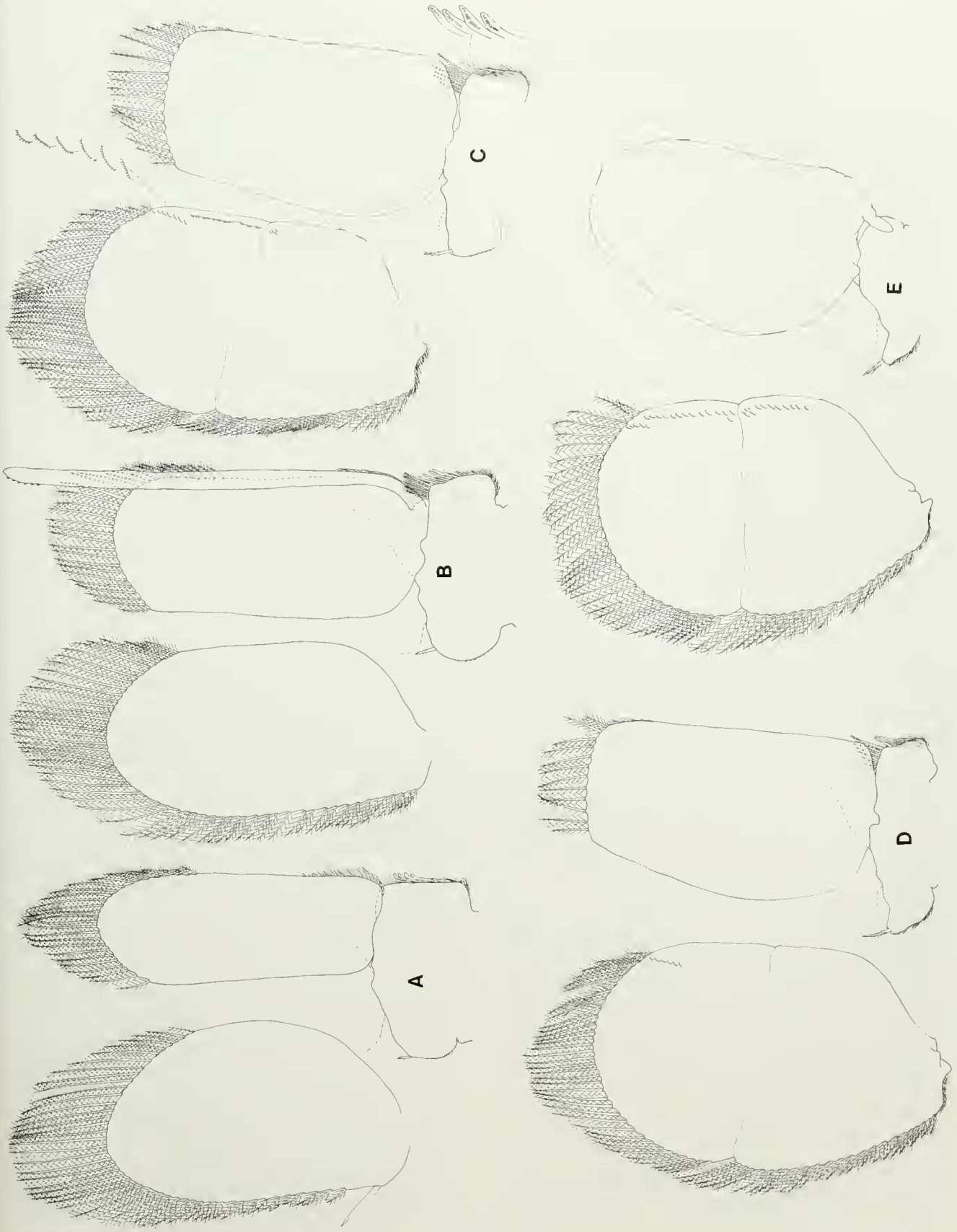

Figure 20. *Cirolana harfordi* (SIO C1856), male: A, pleopod 1 (left). B, pleopod 2 (left). C, pleopod 3 (left). D, pleopod 4 (left). E, pleopod 5 (left).

II–VII visible dorsally (Figs. 11C, D). Pereopod I stout, with simple, stout, and molariform (squat, truncate) spines; ischium with 1 molariform spine and merus with 6 molariform spines on inferior margin; merus with 1 very large spine on superior margin; propodus with 4 blunt spines on inferior margin (Fig. 19A). Pereopods IV–VII long, with many simple and serrate spines and stout, basally denticulate spines as figured (Fig. 19B, C). Penes very small, wartlike processes, set somewhat apart near posterior margin of sternite VII (Fig. 19D).

Pleonites 1–2 often covered by pereonite VII. Pleonites 3–5 with row of small tubercles on posterior margin, and occasionally a pair of minute dorsal submedian tubercles on pleonite 5 in larger specimens (Figs. 11C, D). Pleopodal endopods 1–4 with PMS only apically; exopods 1–5 with PMS entirely around lateral margin and extending to distal third of ramus on medial margin (Figs. 20A–E). Pleopods 1–5: peduncles with 1 large circumplumose seta on lateral margin; peduncles of pleopods 4–5 with small lateral lobe. Pleopods 3–5: exopods with ctenate scales on medial side. Pleopod 1: exopod with 1 large proximolateral spine; lateral (outer) margin of endopod straight; peduncle with 5 coupling spines. Pleopod 2: appendix masculina, with distal spinelets, extends well beyond apex of endopod; peduncle with 4 coupling spines and 5 plumose setae (Fig. 20B). Exopod of pleopod 3 with marginal incisions (Figure 20C). Pleopod 4: peduncle with 4 coupling spines and 6 plumose setae; exopod with marginal incisions (Fig. 20D). Pleopod 5: incisions on exopod nearly complete (Fig. 20E).

Pleotelson subtriangular, apex narrowly rounded, with 9–36 marginal spines, interspersed with PMS; adult males with 2 large dorsal submedian tubercles or carinae, usually absent in females (Figs. 11C, D). Uropods longer than pleotelson, distally rounded, without apical notches. Uropodal endopod twice as broad as exopod, with 12–15 marginal spines, interspersed with PMS; apical spines large and blunt. Uropodal exopod with 13–17 marginal spines, interspersed with PMS; apical spines large and blunt (Fig. 19E). PMS of pleotelson and uropods with very short setules.

Female.—Similar to male, but usually lacking the 2 large dorsal submedian tubercles or carinae on the pleotelson and the rows of small tubercles on posterior margins of some pereonites and pleonites.

Size.—To maximum length of 20.0 mm.

Distribution.—*C. harfordi* is a widely distributed species in the eastern Pacific. It occurs intertidally at least from Vancouver Island, British Columbia, south about to Magdalena Bay on the west coast of Baja California. There is also a single record from the southern Gulf of California (La Paz Bay). The species has a discontinuous distribution in the North Pacific, according to Bruce and Jones (1981) and Bruce (1986a), being found on the coasts of the Russian Far East, Japan, and Australia.

Remarks.—Bruce and Jones (1981) concluded that *Cirolana harfordi japonica* Thielemann, 1910, was not sufficiently distinct to warrant subspecific status. Bruce (1986a) synonymized *C. toyamaensis* Nunomura, 1982, and *C. thielmanni* Kussakin, 1979, with *C. harfordi*, noting that *C. harfordi* may have been introduced to Australia. *C. harfordi* var. *spongicola* Stafford, 1912, is probably conspecific with *C. diminuta* (see remarks for *C. diminuta*).

Occasional males lack the dorsal tubercles on the pleotelson, and the dorsal tubercles of pleonite 5 are most commonly seen on specimens from the California Channel Islands. All females we have examined lack these tubercles.

Cirolana harfordi is one of the most common littoral isopods in warm and cool temperate waters in the northeastern Pacific, becoming rare in subtropical waters south of west-central Baja California. It is common and often abundant beneath rocks (especially on sandy substrates) and in mussel beds, in the littoral zone and shallow sublittoral region. It infrequently occurs subtidally to depths of 135 m. Hewatt (1937) recorded densities as high as 11,521 per square meter in Monterey mussel beds. Johnson (1974, 1976a,b) reported *C. harfordi* preying most commonly on small polychaetes (0.1–0.5 mm in diameter), said to be consumed whole. Johnson also found them preying on a variety of small crustaceans, particularly amphipods and copepods, and also scavenging on dead animal matter. Johnson's work suggested prey/food location by *C. harfordi* is primarily by olfactory means. He also found that ovigerous females seldom, if ever, leave the safety of their underrock shelter or other hiding places to feed, fasting for the entire 3–4 month brooding period. Johnson claimed that most females "probably" died (or were preyed upon) after the first brood, few surviving to produce a second; laboratory populations, however, survived through 3 or more broods under "optimal conditions" (Johnson 1976a). Fecundity ranged from 18 to 68 eggs per brood. Johnson proposed a mean 2-year lifespan for *C. harfordi* in nature, with year-round breeding and an average population generation time of 13.9 months.

Lockington (1877) did not designate type specimens or indicate a place of specimen deposition in his original description of *Cirolana harfordi*, published in the *Proceedings of the California Academy of Sciences*. No type specimens are at the California Academy of Sciences or at other museums where Lockington's material was deposited, such as the Academy of Natural Sciences of Philadelphia and the Muséum National d'Histoire Naturelle, Paris. The BMNH does house four probable syntype specimens. These specimens are from the type locality (Santa Rosa Island in the Santa Barbara Channel, California) and were given to the BMNH by Lockington shortly after publication of the species. These specimens conform with others we have examined.

Cirolana namelessensis n. sp.
Figs. 12A, 21, 22

Type material examined.—(1) Male holotype (USNM 252734) and 30 male, female, and manca paratypes (USNM 252735): Ecuador, Galapagos Islands, Nameless Island, intertidal; Sta. 26A, USNM Acc. No. 330765; 22 Feb. 1978; coll. W. B. Hope.

Additional paratypes, Colombian specimens: (2) Pacific coast, Ensenada de Utria, in algae, on dead *Pocillopora robusta*, 5 m; SDNHM A.0147; 12 Aug. 1984; coll. G. E. Ramos-Tafur; 1 specimen. (3) Malpelo Island, coll. for P. W. Glynn; SDNHM A.0149; 29 Feb.–3 Mar. 1972; 12 specimens. (4) Pacific Colombia, Malpelo Island, dive #5, N.E. wall, ca. 10 ft.; LACM (00000); 2 Mar. 1972; 23 specimens. (5) Malpelo Island, intertidal; SDNHM A.0148; 9 Mar. 1972; 8 specimens. Galapagos specimens: (6) Tower Island, Darwin Bay, coral gathered at Seal Beach No. 1 by "Carl"; R/V *Velero III* Sta. 94-33, USNM; 22 Feb. 1933; 8 postmanca specimens. (7) Albemarle Island, Tagus Cove, coral from north shore by "Carl"; USNM 152-1934; 14 Jan. 1934; 1 male and 3 females. (8) Albemarle Island, Albemarle Point, shore collecting about *Porites* heads, low tide; R/V *Velero III* Sta. 69-33, USNM Acc. No. 122445; 11 Feb. 1933; 1 specimen. (9) Indefatigable Island, Gordon Bay; Allan Hancock Expedition; R/V *Velero III* Sta. 135-34, USNM Acc. No. 131571; 8 Dec. 1934; coll. W. L. Schmitt; 3 females. (10) Charles Island (= Isla Santa Maria), near Post Office Bay, from coral, inside crater; R/V *Velero III* Sta. 804-38, USNM Acc. No. 148041; 23 Jan. 1938; 2 males and 3 females. (11) Hood Island, from rocky spit, Gardiner Bay; R/V *Velero III* Sta. 27-33, USNM Acc. No. 122445; 25 Jan. 1933; 2 specimens.

Description of male.—Cephalon devoid of tubercles or carinae; width 2.0 times length (Fig. 12A). Small rostrum separates antennules, produced ventrally to partly overlap frontal lamina (Fig. 21C). Antennules short, reaching middle of pereonite I, with aesthetascs and simple and palmate setae as figured; first 2 articles

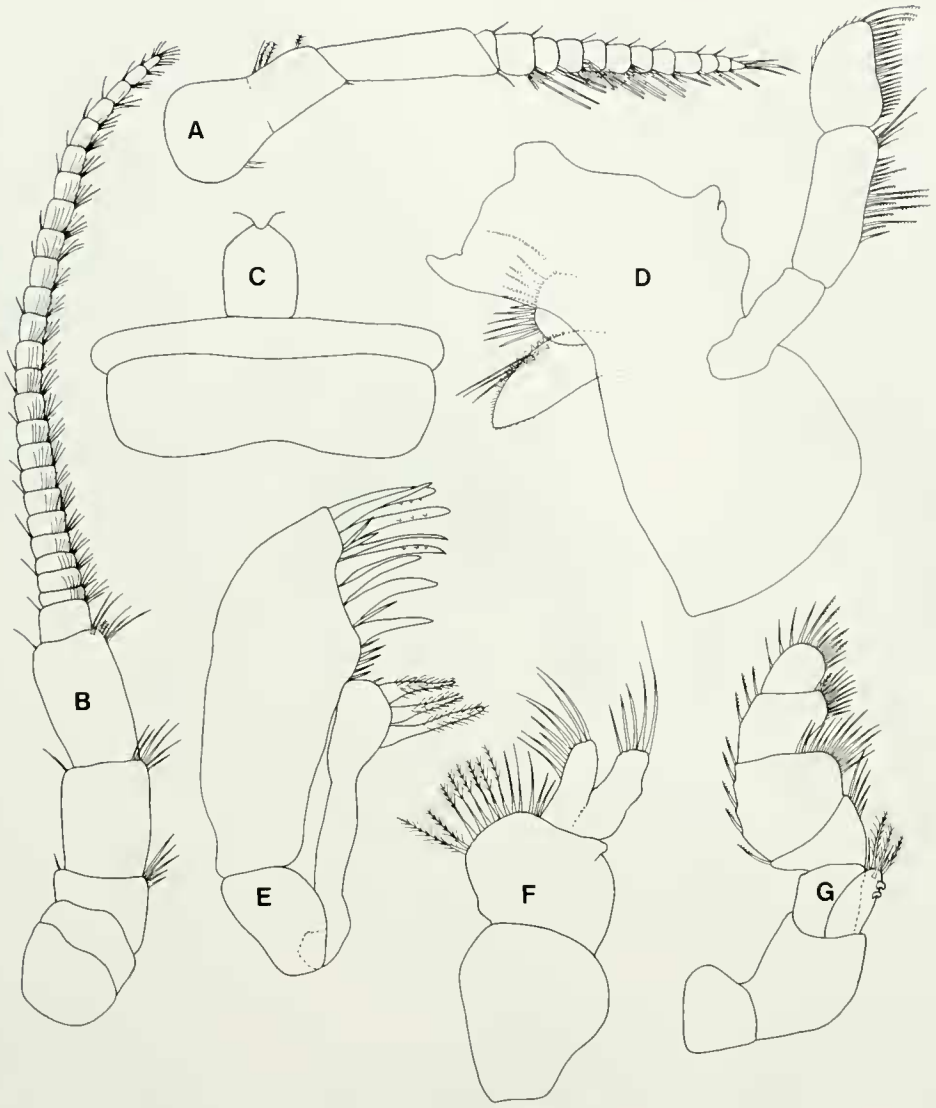

Figure 21. *Cirolana namelessensis* n. sp. (USNM 252734), holotype, male: A, antennule. B, antenna. C, frontal lamina, clypeus, and labrum. D, mandible. E, maxillule. F, maxilla. G, maxilliped.

of peduncle largely fused; flagellum of 10–12 articles (Fig. 21A). Antenna long, reaching anterior margin of pereonite V, with simple and palmate setae as figured; flagellum of 25–31 articles (Fig. 21B). Frontal lamina pentagonal; labrum much longer, but slightly narrower than clypeus (Fig. 21C). Mandibular spine row with 11 large simple spines and 1 long seta; molar process with stout spines, many short setae on posterior margin, and 3 very long setae arising from proximoanterior region; middle palp article with about 9 comb and 11 simple setae, distal article with many simple setae and 3 terminal comb setae (Fig. 21D). Maxillule medial lobe with 3 stout circumplumose spines and 1 small seta; lateral lobe with 11 stout and 5 small spines; 3 of the stout spines armed with barbs (Fig. 21E). Maxilla medial lobe (gnathal surface) with 2 fully plumose, 6 distally plumose, and 5 simple setae; lateral lobes with 8 and 5 simple setae, respectively (Fig. 21F). Maxillipedal endite short, with 2 coupling spines, 2 apical and 1 subapical plumose setae, and 2 simple apical setae; palp margins with simple, plumose, and comb setae as figured (Fig. 21G).

Pereon widest at pereonite V. Pereonite VII with row of small tubercles along posterior margin. Coxae IV–VII visible in dorsal view; VI–VII with oblique posterior carina; VII produced posteriorly to midlength of pleonite II (Fig. 12A). Pereopod I stout, with simple setae as figured; inferior margin of merus with 5 short, blunt, molariform spines; propodus' distal inferior margin with 3 very short blunt molariform spines; dactylus with small spine and setae set below base of primary unguis and cluster of setae on superior margin at base of unguis (Fig. 22A). Pereopod IV: margins of ischium–propodus with large stout spines bearing basal denticles; dactylus with 1 small spine (Fig. 22B). Pereopod VII long; inferior and distal margins of ischium–propodus with serrate spines and stout spines bearing basal denticles; dactylus with 1 small spine (Fig. 22C). Penes short, small, set somewhat apart near posterior margin of sternite VII (Fig. 22D).

Pleon broadest at pleonites 2 and 3. Pleonite 1 almost completely overlapped by pereonite VII (visible medially). Posterolateral angles of pleonite 3 produced, partly encompassing pleonite

Figure 22. *Cirolana namelessensis* n. sp. (USNM 252734), holotype, male: A, pereopod I. B, pereopod IV. C, pereopod VII. D, penes. E, dorsal view of uropod. F, pleopod 1. G, pleopod 2. H, pleopod 3. I, pleopod 4. J, pleopod 5.

4. Pleonites 3–5 with 2 submedian tubercles, becoming larger posteriorly (Fig. 12A). Pleopodal rami with PMS as figured (Figs. 22F–J). Pleopod 1: peduncle's medial margin with 4 coupling spines, lateral margin with 1 simple spine; endopod 0.5 width of exopod, lateral (outer) margin concave; exopod with single simple spine on proximolateral margin (Fig. 22F). Pleopod 2: peduncle's medial margin with 4 coupling spines and 3 plumose setae, lateral margin with 1 small spine; appendix masculina length 1.2 times length of exopod, narrowing to acute apex with short barbed setae (Fig. 22G). Pleopod 3: peduncle's medial margin with 3 coupling spines and 1 plumose seta; lateral margin with 1 short simple spine; exopod with short marginal incisions and ctenate scales on medial margin (Fig. 22H). Pleopod 4: peduncle's medial margin with 3 coupling spines and 4 plumose setae, lateral margin with 1 simple spine; exopod with short marginal incisions and ctenate scales on medial margin (Fig. 22I). Pleopod 5: exopod with short marginal incisions and ctenate scales on medial margin (Fig. 22J).

Pleotelson triangular, lateral margins straight, apex rounded, with 6–9 stout marginal spines interspersed with many simple setae; posterior pleonites and pleotelson with 2 longitudinal submedian tuberculate carinae, most prominent in larger individuals, occasionally with several smaller tubercles located between the 2 longitudinal carinae (Fig. 12A). Uropods with scattered dorsal chromatophores; inner angle of peduncle with distal PMS; rami with small apical notches and a group of long simple setae arising from each notch (Fig. 22E); margins of uropodal rami weakly serrate and somewhat rounded apically (especially endopod), not lanceolate as in *C. nielbrucei*; both rami with spines and PMS on medial and lateral margins. Uropodal exopod 0.67 times width of endopod, extending almost to pleotelson apex; medial margin with 3–4 spines, lateral margin with 5–8 spines, interspersed with PMS. Uropodal endopod extends barely beyond pleotelson apex; medial margin with 5–8 spines, lateral margin with 2–3 spines, interspersed with PMS.

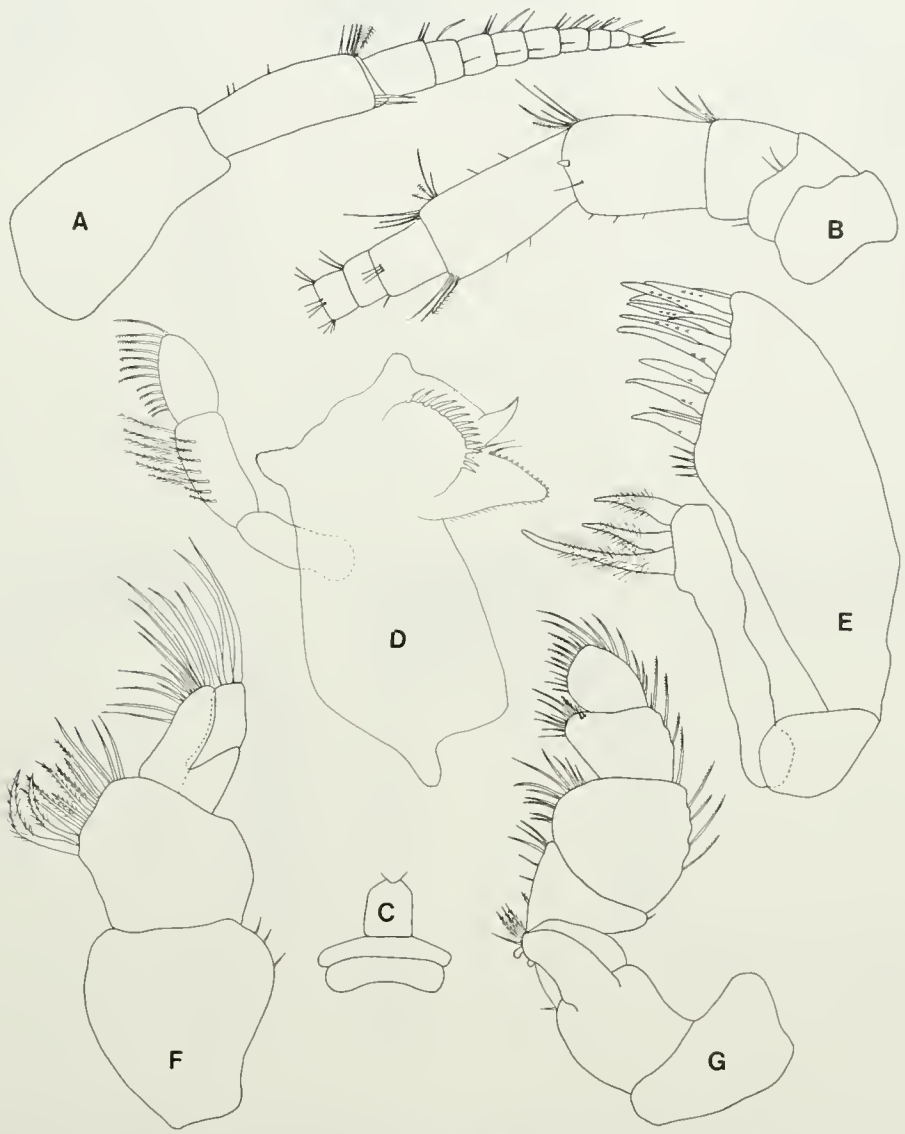

Figure 23. *Cirolana nielbrucei* n. sp. (LACM 77-294.2), paratype, male: A, antennule (right). B, antenna (right). C, frontal lamina, clypeus, and labrum. D, mandible (left). E, maxillule (left). F, maxilla (left). G, maxilliped (left).

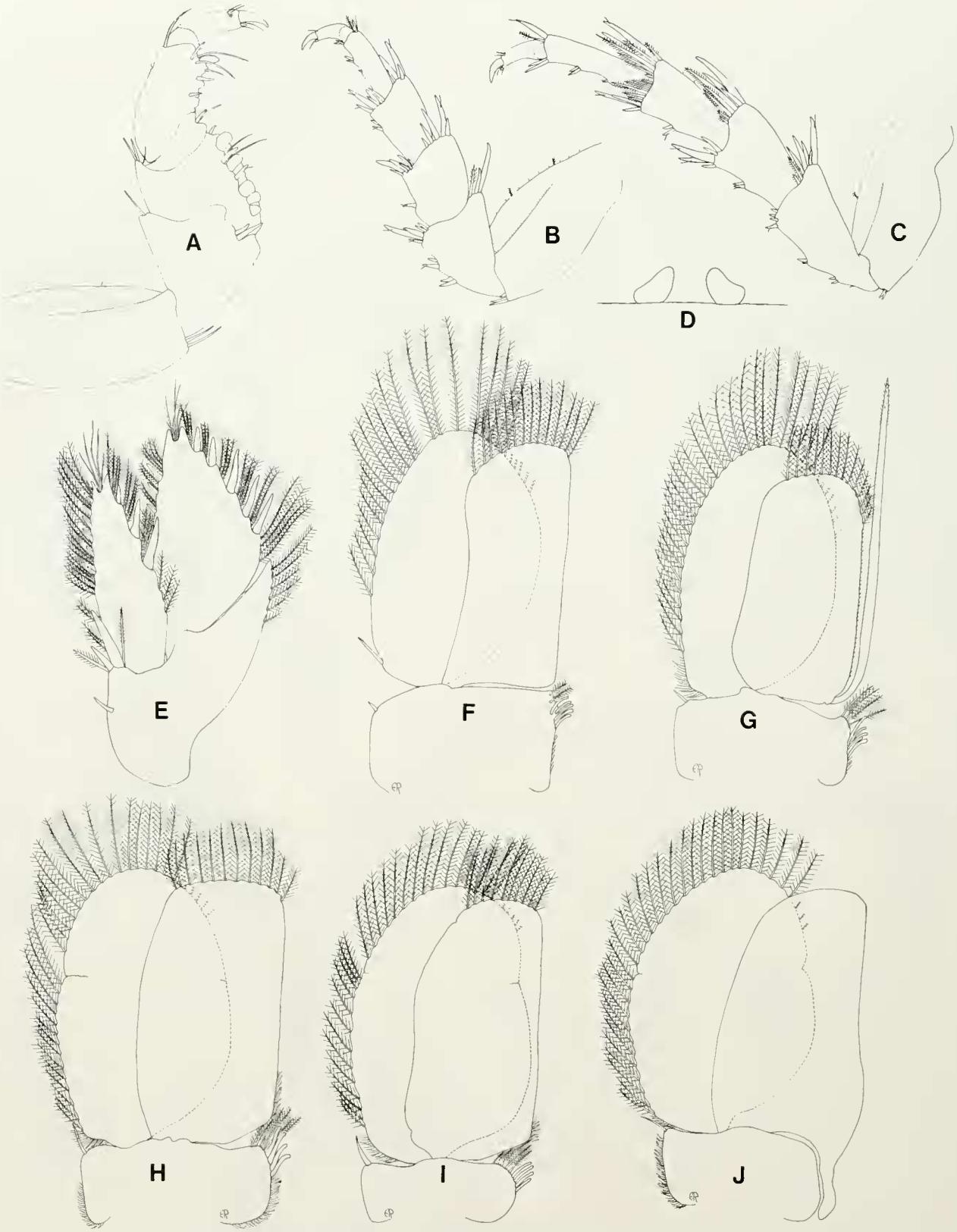

Figure 24. *Cirolana nielbrucei* n. sp. (LACM 77-294.2), paratype, male: A, pereopod I (left). B, pereopod IV (left). C, pereopod VII (left). D, penes. E, ventral view of uropod (left). F, pleopod 1 (left). G, pleopod 2 (left). H, pleopod 3 (left). I, pleopod 4 (left). J, pleopod 5 (left).

Female.—Similar to male. Dorsal tubercles on pleon and pleotelson somewhat variable in size; occasionally larger in the female than in the male.

Size.—Small, to maximum length of 8.4 mm.

Distribution.—An intertidal–shallow subtidal species preferring coral rubble, coral, and rocky substrates, and so far known from only three areas: the Galapagos Islands (Nameless, Albermarle, Tower, Indefatigable, Hood, and Charles islands); Malpelo Island, Colombia; and Ensenada de Utria, Colombia (on the Pacific coast).

Remarks.—Cirolana namelessensis has affinities with both the *C. parva* group of sibling species, *sensu* Bruce and Bowman (1982) and Bruce (1986a), and the "tuberculate" group of *Cirolana* species (Bruce, 1986a). The characters most readily distinguishing *Cirolana namelessensis* from similar appearing species in the tropical eastern Pacific are as follows: the tuberculation of the posterior pleonites and pleotelson (the only other tropical eastern Pacific *Cirolana* species with dorsal tuberculation is *C. harfordi*, which can immediately be distinguished from *C. namelessensis* by its lacking apical notches on the uropodal rami and the shape and number of spines of the pleotelson and uropods. The apical notches of the uropodal rami are smaller (not as deep) than in *C. parva* and *C. diminuta.*

Etymology.—Named for the type locality: Nameless Island, Galapagos Islands, Ecuador.

Cirolana nielbrucei n. sp.
Figs. 12B, 23, 24

Type material examined.—(1) Holotype (LACM 77-294.1), male, and 45 paratypes, 41 at LACM (77-294.2) and 4 at SDNHM (A.0150): Mexico, Gulf of California, Punta Chivato; transect #1, quadrat #7, 1 of 4; 16 July 1977; coll. R. C. Brusca, R. Zimmerman, and R. Winn.

Additional paratypes: (2) Mexico, Sonora, Tiburon Island; Acc. No. 159124, USNM 86313; 3 Apr. 1940; coll. E. F. Ricketts; 9 specimens. (3) Mexico, Baja California (Gulf), El Bajo, near Loreto, formalin washing of shallow subtidal rocks; EW180-18, LACM; 20 Aug. 1980; coll. E. W. Iverson; 50+ specimens. (4) Mexico, Baja California (Gulf); 25°31' N, 111°04' W, taken with "Chemfish" and scuba at 3–5 m; RR65-37, Acc. No. BI-6549, SIO C2444; 11 July 1965; coll. R. Rosenblatt; 1 female. (5) Mexico, Baja California (Gulf), Espiritu Santo Island, shore collecting; R/V *Velero III* Sta. 634-37, USNM Acc. No. 144492; 6 Mar. 1937; 1 male.

Description of male.—Cephalon devoid of tubercles, 2.2 times wider than long (Fig. 12B). Rostrum small, barely overlapping frontal lamina (Fig. 23C). Antennule short, reaching just beyond anterior margin of pereonite I, with simple and plumose setae and aesthetases; flagellum of 8 or 9 articles (Fig. 23A). Antenna long, reaching middle of pereonite IV; flagellum of 26–28 articles; peduncular article 4 with characteristic subapical denticle (difficult to see on small specimens) (Fig. 23B). Frontal lamina pentagonal (Fig. 23C). Mandibular spine row forms a large round lobe with 13 robust spines, 2 of them very long; molar process with 26 small acute marginal spines and many short simple setae on posterior margin; middle article of mandibular palp with 10 plumose setae (not all figured); distal article with approximately 20 comb setae (Fig. 23D). Maxillule lateral lobe with 10 stout barbed spines, 1 simple spine, and 4 small slender subapical setae (Fig. 23E). Maxilla medial lobe with 4 simple setae, 6 plumose setae, and 2 long circumplumose setae; lateral lobes with 11 and 4 simple setae, respectively; lateral margin of basal article with 3 small setae (Fig. 23F). Maxillipedal endite very short, with 2 coupling spines, 3 plumose, and 1 simple seta apically; palp margins with simple and comb setae as figured (Fig. 23G).

Pereon broadest at pereonites V and VI. Pereon dorsum devoid of tubercles or carinae. Posterior angles of coxae VII very long and acute, produced past anterior margin of pleonite 2; coxae IV–VII visible in dorsal view (Fig. 12B). Pereopod I short and stout, with several simple setae; inferior margin of merus with 5 blunt molariform spines and 3 simple spines; inferior margin of propodus tuberculate, with large blunt distal spines and 3 small spines; dactylus with small blunt apical spine (Fig. 24A). Pereopod IV ambulatory with numerous large spines on all articles as figured; dactylus with 1 seta and 1 apical spine at base of unguis (Fig. 24B). Pereopod VII with robust serrate spines and stout, basally denticulate spines on all articles as figured; dactylus with 1 seta and 1 apical spine at base of unguis (Fig. 24C). Penes short, small, set somewhat apart near posterior margin of sternite VII (Fig. 24D).

Pleonites 1–4: posterolateral angles produced, each partly encompassing following pleonite. Pleon without dorsal tubercles or carinae (Fig. 12B). Pleopodal rami with PMS as figured (Figs. 24F-J). Pleopod 1: peduncle's medial margin with 5 coupling spines and 2 plumose setae, lateral margin with 1 small simple spine; endopod 0.67 width of exopod, lateral (outer) margin concave; exopod with 1 stout seta on proximolateral margin (Fig. 24F). Pleopod 2: peduncle's medial margin with 5 coupling spines and 4 plumose setae, lateral margin with 1 spine; appendix masculina 1.25 times as long as exopod, narrowing to acute apex with short barbed setae (Fig. 24G). Pleopod 3: peduncle's medial margin with 4 coupling spines and 6 plumose setae; lateral margin with 1 simple spine; exopod with short marginal incisions (Fig. 24H). Pleopod 4: peduncle's medial margin with 4 coupling spines and 5 plumose setae; lateral margin with a simple spine; exopod with short marginal incisions (Fig. 24I). Pleopod 5: peduncle with 1 simple spine on lateral margin; exopod with short marginal incisions (Fig. 24J).

Pleotelson triangular, lateral margins straight, not convex as in *C. parva*; apex narrow, rounded, with 6–7 stout marginal spines, interspersed with many simple setae; dorsum without tubercles or carinae (Fig. 12B). Uropods extend slightly beyond pleotelson apex, distally acute; margins strongly serrate (much more so than in *C. parva* or *C. diminuta*); large apical notch on both rami, a group of long simple setae arising from each notch; both rami with large spines and PMS on medial and lateral margins. Uropodal exopod 0.50 width of endopod and slightly shorter than endopod; medial margin with 2–3 stout spines, lateral margin with 7–8 stout spines (medial spines larger than lateral spines), interspersed with many PMS. Uropodal endopod's medial margin with 4–5 stout spines, lateral margin with 3 stout spines (lateral spines much longer than medial spines), interspersed with many PMS. Uropodal peduncle's medial margin with distal PMS, lateral margin with 3 stout spines, one subapical and 2 apical (Fig. 24E).

Female.—Similar to male.

Size.—Small, to maximum length of 7.85 mm.

Distribution.—An intertidal and shallow subtidal species, so far known only from the central and southern Gulf of California.

Remarks—Cirolana nielbrucei belongs to the *C. parva* group of sibling species, *sensu* Bruce and Bowman (1982), and Bruce (1986a). The characters most readily distinguishing *C. nielbrucei* from similar appearing species in the tropical eastern Pacific are as follows: spination of the pleotelson (always 6 or 7 marginal spines in *C. nielbrucei*, never more); shape of pleotelson (lateral margins straight); shape of uropodal rami (apices very acute, margins very serrate); presence of a subapical denticle on article 4 of antennal peduncle; and spination of the uropodal rami (varies only slightly from *C. parva*, although the spines on the medial margin of the endopod are much longer and stouter in *C. nielbrucei*). Sessile loricated peritrich ciliates have been observed among the spines on the medial margin of pereopod VII in some specimens.

Etymology.—We take pleasure in naming this species after the

indefatigable Southern Hemisphere isopodologist, Niel L. Bruce.

Cirolana parva Hansen, 1890
Figs. 12C, 25, 26

Synonymy.—Emended and subsequent to Bruce and Bowman 1982: 325.

Menzies and Glynn 1968: 38. Schultz 1969: 185. Brusca 1980: 228. Brusca and Iverson 1985: 35. Bruce 1985: 714; 1986a: 220; 1986b: 549. Kensley and Schotte 1989: 135. Schotte et al. 1991: 225.

Non-*Cirolana parva*: see Bruce and Bowman 1982: 325.

Type material examined.—(1) "Lectotype" (ZMUC), male, West Indies, St. Thomas. "Syntypes" (ZMUC): (2) female, West Indies; (3) West Indies, 5 specimens; (4) West Indies, St. Croix, 2 specimens (in very poor condition); (5) 25°N, 34°E, 2 specimens; (6) [no locality], 1 specimen; (7) Pacific Ocean, Samoa, 1 specimen.

Other material examined.—Atlantic specimens. Mexico: (8) Campeche, 5 mi. N. of Sebaplaya; USL-TFE-1, SDNHM; 6 Jan. 1977; 3 females; (9) Campeche, 5 mi. N. of Sebaplaya; USL-TFE-1, SDNHM; 6 Jan. 1977; coll. J. Martin; 1 specimen; (10) Campeche, 10 mi. N.E. of Chompoton, "errant collections off grass beds"; USL-TFE-11B, SDNHM; 7 Jan. 1978; 1 male and 1 gravid female; (11) Campeche, 10 mi. N. of Chompoton; USL-TFE-1, SDNHM; 6 Jan. 1977; 1 manca; (12) Quintana Roo, Cozumel Island; USNM Acc. No. 229190; 8 Apr. 1960; 50+ specimens; (13) Quintana Roo, between Lawrence Point and Fupar Point; USNM Acc. 229190; 5 Apr. 1960; 24 specimens. (14) Puerto Rico; Acc. No. 259321, USNM 112841; coll. P. W. Glynn; 11 specimens. (15) Costa Rica, Limon Province, Cahuita, infauna of intertidal coral rock, from in front of "Jenny's house," with 2 pink sphaeromatids; PMD-81-2, SDNHM; 22 Aug. 1981; coll. P. M. Delaney, C. Stepien, P. Pepe; 1 male.

Pacific specimens: (16) Mexico, Oaxaca, Sacrificios Island, 15°40' N, 96°14' W, taken with scuba at 13 m; Acc. No. B178-15, TEPE 78-15, R/V *Alpha Helix*, SIO C4123; 7 Apr. 1978; coll. W. Newman and S. Luke; 1 female. Costa Rica: (17) Guanacaste Province, Salinas Bay, shore collecting on beach beyond reef, on sand and stone; R/V *Velero III* Sta. 474-35, USNM Acc. No. 131571; 10 Feb. 1935; 3 females; (18) Puntarenas Province, Quepos, Cocal Beach, sandy beach, with *Excirolana*; USNM 150034; 1 female; (19) Cocos Island, around point to northwest of Chatham Bay, from "roach trap" in morning; Acc. No. 122445, USNM 68433; 1 Mar. 1933; coll. W. L. Schmitt; 80+ specimens; (20) Cocos Island, from "roach trap"; USNM Acc. No. 122445; 1 Mar. 1933; 50+ specimens; (21) Cocos Island, Bajo Alcyone, 35 m; LACM; 27 Mar. 1989; coll. K. Kaiser; 3 specimens; (22) Parker Bay, off small island at N. shore, shore collecting; R/V *Velero III*

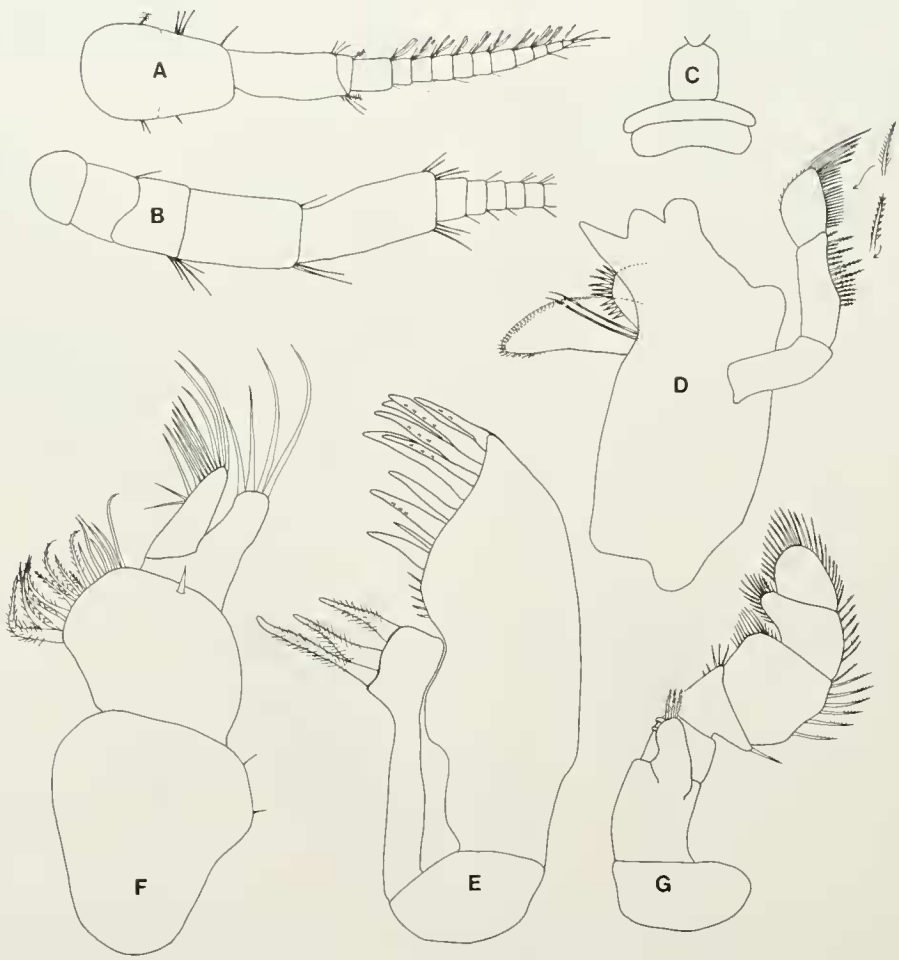

Figure 25. *Cirolana parva* (USNM Acc. No. 93322), male: A, antennule. B, antenna. C, frontal lamina, clypeus, and labrum. D, mandible. E, maxillule. F, maxilla. G, maxilliped.

Sta. 466-35, USNM Acc. No. 131571; 9 Feb. 1935; 1 specimen. (23) Panama, Ladrones Island, 7°52' N, 82°27' W, taken intertidally with scuba; TEPE 70-13, R/V *Alpha Helix*, Acc. No. 70-12, SIO C3814; 19 Sept. 1970; coll. W. Newman and S. Luke; 1 male. Ecuador, Galapagos Islands: (24) Tower Island, Darwin Bay, from "roach trap," 2 mornings; Acc. No. 122445, USNM 68418; 23–24 Feb. 1933; coll. W. L. Schmitt; 150+ specimens; (25) Tower Island, Darwin Bay, from coral collected at Seal Beach, No. 1, by "Carl"; R/V *Velero III* Sta. 94-33, USNM Acc. No. 122445; 22 Feb. 1933; 1 specimen; (26) Tower Island, Darwin Bay, from "roach trap"; Acc. No. 122445, USNM 68437; 21 Feb. 1933; coll. W. L. Schmitt; 100+ specimens; (27) Tower Island, Darwin Bay, coral gathered at Seal Beach, No. 1; R/V *Velero III* Sta. 94-33, USNM Acc. No. 122445; 22 Feb. 1933; 1 specimen; (28) Seymour Island, from "roach trap" attached to lobster trap; Acc. No. 122445, USNM 68424; 18 Feb. 1933; 60+ specimens; (29) Albemarle Island, Albemarle Point, shore collecting; R/V *Velero III* Sta. 69-33, LACM; 11 Feb. 1933; 4 specimens; (30) Indefatigable Island, Gordon Bay; R/V *Velero III* Sta. 315-35, USNM Acc. No. 131571; 8 Dec. 1934; 1 specimen; (31) Indefatigable Island, Academy Bay, dredged; R/V *Velero III* Sta. 169-34, USNM Acc. No. 128938; 20 Jan. 1934; 1 specimen; (32) Indefatigable Island, opposite Gordon Rocks, from coral in shallow water; R/V *Velero III* Sta. 315-35, LACM; 8 Dec. 1935; 1 female; (33) Chase Island, Post Office Bay, from "roach trap" on fish trap; Acc. No. 122445, USNM 68434; 6 Feb. 1933; coll. W. L. Schmitt; 1 female; (34) Hood Island, Gardiner Bay, rock spit; USNM Acc. No. 122445; 25 Jan. 1933; 1 male; (35) Hood Island, Gardiner Bay, Osborne Island; Acc. No. 122445, USNM 68435; 26 Jan. 1933; coll. W. L. Schmitt; 1 specimen. Ecuador (mainland): (36) Manta, shore; #400, USNM Acc. No. 131571; 19 Jan. 1935; 1 male; (37) 1 mi. S. of Manta, from shore, reef west of breakwater; #403, USNM Acc. No. 124571; 20 Jan. 1935; 1 male and 1 female; (38) Salinas, with worm galleries; #1–4, USNM Acc. No. 93322; 12-15 Sept. 1926; coll. W. L. Schmitt; 3 specimens; (39) Salinas; #2, USNM Acc. No. 93322; 13 Sept. 1926; coll. W. L. Schmitt; 1 male; (40) Salinas; #1, USNM Acc. No. 93322; 12 Sept. 1926; coll. W. L. Schmitt; 2 males; (41) S. side of Santa Elena Point; #7, USNM Acc. No. 93322; 17 Sept. 1926; 1 specimen; (42) La Libertad, Bravo Point, S. side of Santa Elena Point; #7, USNM Acc. No. 93322; 17 Sept. 1926; coll. W. L. Schmitt; 5 specimens; (43) La Libertad, Bravo Point, S. side of St. Elena Point, shore collecting; R/V *Velero III* Sta. 19-33, USNM Acc. No. 122445; 21 Jan. 1933; 1 female.

Description of male.—Cephalon devoid of tubercles, about 2.5 times wider than long, with small rostral process, often with interocular furrow. Posterior region of cephalon often with short lateral incisions on margins. Posterior portion of eyes covered by anterolateral angles of pereonite 1 (Fig. 12C). Antennule very short, reaching beyond anterior margin of pereonite I, with simple and palmate setae and aesthetases as figured; flagellum of 7–12 articles (Fig. 25A). Antenna long, reaching pereonite IV, in small specimens reaching pereonite V, with simple setae; flagellum of 22–33 articles (distal portion not figured) (Fig. 25B). Frontal lamina pentagonal, overlapped anteriorly by distal portion of rostral process (Fig. 25C). Mandibular spine row forms large lobe with comblike row of long spines, with 2 long setae at the base; molar process with about 30 small acute marginal spines and numerous small simple posterior marginal setae; middle article of palp with serrate setae; distal article with comb and plumose setae (Fig. 25D). Maxillule lateral lobe with 10 stout simple spines, 5 largest spines armed with small barbs (Fig. 25E). Maxilla basal article with 2 short simple spines on lateral margin; medial lobe with 9 plumose and 6 simple setae, 1 simple seta near insertion of lateral lobes; lateral lobes with 11 and 4 long simple setae, respectively (Fig. 25F). Maxillipedal endite very short, with 2 coupling spines, minute proximal lobe, and 3 distal circumplumose setae; palp with simple and comb setae as figured (Fig. 25G).

Pereonite I 1.5 times length of others. Pereon broadest at pereonites IV and V. Coxae IV–VII projecting beyond posterior margins of pereonites and visible dorsally. Pereon without dorsal tubercles, carinae, or setae (Fig. 12C). Pereopod I short, stout; merus armed with 5 blunt robust molariform spines and several simple spines on inferior margin; propodus with 2 simple spines on inferior margin and 1 blunt spine and 5 simple setae on distal angle of inferior margin; dactylus with small simple seta at base and at junction with unguis on inferior margin and a group of 5 simple setae on superior margin near unguis (Fig. 26A). Pereopod IV long and ambulatory, with large stout simple, serrate, and basally denticulate spines as figured (Fig. 26B). Pereopod VII long, with many simple, serrate, and basally denticulate spines as figured (Fig. 26C). Penes small (but larger than in *C. diminuta*) and set close together on posterior region of sternite VII, in line with the inner (medial) margins of peduncles of first pleopods (Fig. 26D).

Pleon widest at pleonite 2; pleonites 2–4 with posterolateral angles somewhat acute, partly encompassing pleonites 3–5 respectively (Fig. 12C). Pleopodal rami with PMS as figured (Figs. 26F-J). Pleopod 1: peduncle's medial margin with 4 coupling spines, lateral margin with 1 large simple spine; endopod's lateral (outer) margin very weakly concave; exopod with 1 stout spine on proximolateral margin; endopod 0.75 width of exopod (Fig. 26F). Pleopod 2: peduncle's medial margin with 4 coupling spines and 5 plumose setae, lateral margin with 1 simple spine; appendix masculina 1.2 times as long as exopod, distal part narrowing to slender apex, usually with a threadlike extension and small marginal (and occasionally medial) spines (Fig. 26G). Pleopod 3: peduncle's medial margin with 4 coupling spines and 5 plumose setae; lateral margin with 1 simple spine; exopod with short marginal incisions (Fig. 26H). Pleopod 4: peduncle's medial margin with 4 coupling spines and 5 plumose setae; lateral margin with 1 simple spine; exopod with short marginal incisions (Fig. 26I). Pleopod 5: peduncle with 1 simple spine on lateral margin; exopod with short marginal incisions (Fig. 26J).

Pleotelson subtriangular, lateral margins straight or slightly convex, apex rounded, with 8 stout marginal spines interspersed with many PMS (occasional specimens can have 5 spines on one side of the pleotelson, for a total of 9 marginal spines); pleotelson lacks carinae or tubercles (Fig. 12C). Uropods extend to or slightly beyond apex of pleotelson, margins serrate and notched apically, not distally rounded as in *C. harfordi*; rami more narrow than in *C. harfordi*; group of long simple setae arises from each apical notch; both rami with spines and PMS on medial and lateral margins. Uropodal exopod half as wide and slightly shorter than endopod; medial margin with 3 stout simple spines, lateral margin with 7 or 8 stout simple spines. Uropodal endopod's medial margin with 4 or 5 stout simple spines, lateral margin with 2 or 3 stout simple spines. Uropodal peduncle's medial margin with distal plumose setae; 1 mediolateral marginal spine; a group of spines and setae lies near the articulation of the exopod (Fig. 26E).

Female.—Similar to male.

Size.—Small, to maximum length of 8 mm.

Distribution.—Until recently, *C. parva* was thought to be a eurythermal, circumtropical, and warm-temperate species (Miller 1968; Menzies and Glynn 1968). Bruce and Bowman (1982) redescribed the species, noting that reliable records existed only for the Caribbean and Gulf of Mexico. However, *C. parva* is also a common member of the tropical eastern Pacific fauna, ranging from southern Mexico (Oaxaca) south to the Galapagos Islands and Ecuador, in shallow subtidal and intertidal habitats. Atlantic locales for specimens examined in this study include the "West Indies," St. Thomas, Puerto Rico, Yucatan Peninsula, and Costa Rica. As noted

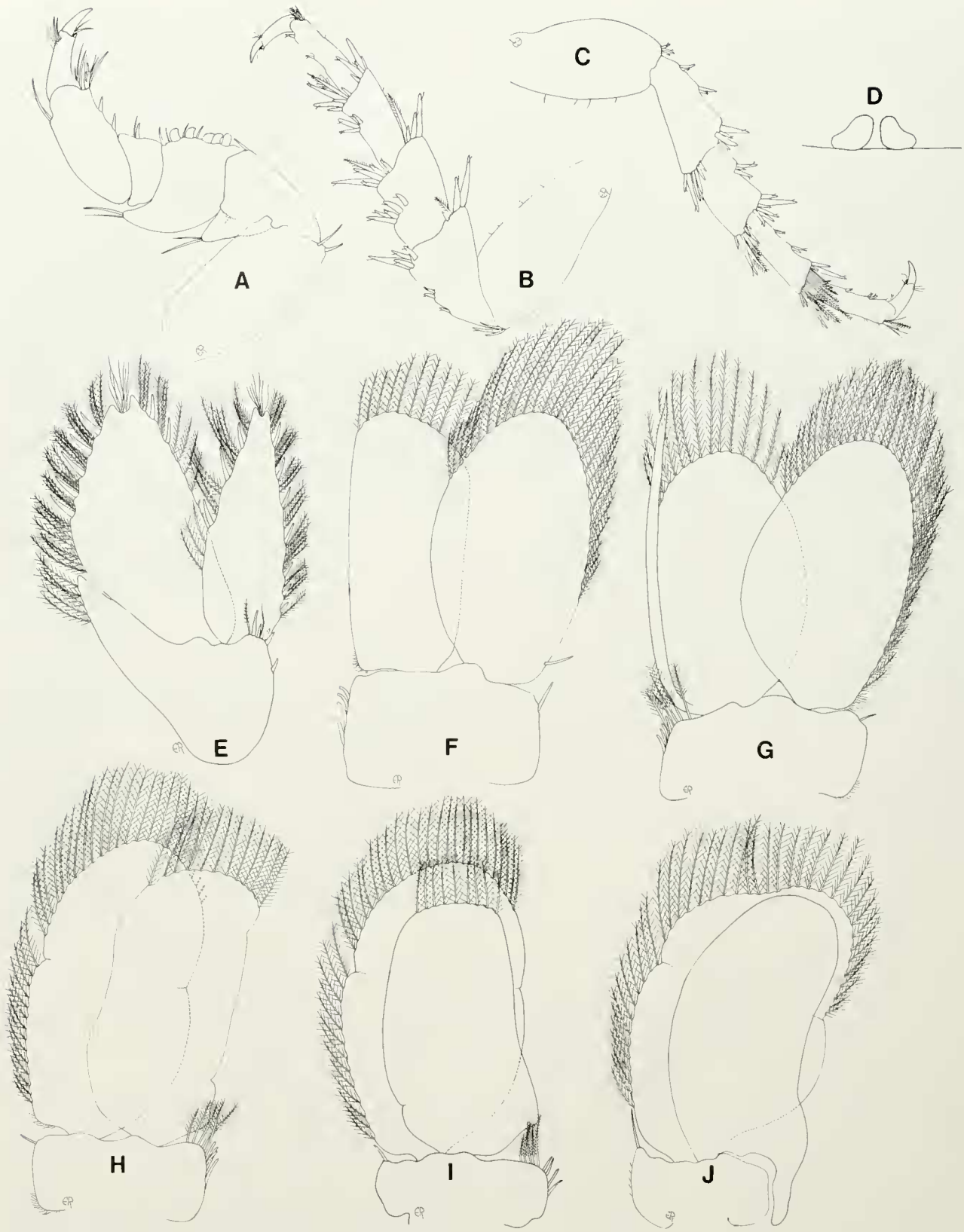

Figure 26. *Cirolana parva* (USNM Acc. No. 93322), male: A, pereopod I. B, pereopod IV. C, pereopod VII. D, penes. E, ventral view of uropod. F, pleopod 1. G, pleopod 2. H, pleopod 3. I, pleopod 4. J, pleopod 5.

by Hansen (1890) and Bruce and Bowman (1982), one of the type specimens is labeled as being from "Samoa."

Remarks.—Bruce and Bowman (1982) raised the probability that what has passed for *Cirolana parva* in the past is in fact a complex of closely related sibling species. They confirmed records of *C. parva* from the Caribbean and Gulf of Mexico, and removed *C. diminuta* from synonymy with it. After examination of the type specimens, Bruce and Bowman's material, and eastern Pacific specimens, we conclude that *C. parva* does occur in the tropical eastern Pacific and is thus a tropical amphi-American species. The characters distinguishing *C. parva* from the very similar *C. diminuta* are discussed above (see under "Remarks" for *C. diminuta*). Hansen (1890) did not designate a type locality for *Cirolana parva*. Bruce and Bowman (1982) noted this and designated St. Thomas, West Indies, as the type locality, basing this on label data of dissected syntypes. Hansen (1890) did not figure the pleopods, but Bruce and Bowman's (1982) figures of "syntypes" show pleopods 4 and 5 with a complete transverse suture across the endopod. However, the ZMUC specimen labeled "lectotype" and other material we have examined lack complete endopodal sutures (see Fig. 26I and J).

Conilera Leach, 1818

Type species.—*Oniscus cylindraceus* Montagu, 1804. The deposition of the type is unknown.

Conilera Leach, 1818: 348. Desmarest 1825: 304. Milne Edwards 1840: 242. Bate and Westwood 1867: 302. Hansen 1890: 358. Richardson 1905: 116. Kussakin 1979: 216. Bruce 1985: 714; 1986a: 220. Wetzer, et al. 1987: 1. Kensley and Schotte 1989: 139.

Description.—Body 4.8–5.2 times longer than broad; dorsum smooth, without ornamentation. Eyes small, separated by greater than 2 eye-widths. Rostrum minute or absent. Frontal lamina, clypeus, and labrum sessile, not projecting; narrow, anteriorly expanded frontal lamina separates bases of antennules and antennae; clypeus wider than long, and wider than labrum. Antennular peduncle 3-articulate; basal article articulated at right angle to remaining articles. Antennal peduncle 5-articulate; articles 3 and 4 subequal; 4th peduncular article with an elongate seta on distal posterior angle. Mandible tridentate; spine row a well-developed rounded lobe with stout spines; palp 3-articulate, middle article longest. Maxillule medial lobe with 3 stout circumplumose spines; lateral lobe with 10–12 stout, apical spines. Maxilla medial lobe short, truncate, with many plumose setae; lateral lobe bifurcate with apical simple setae. Maxillipedal palp 5-articulate, with middle article broader than others; endite with 1 coupling hook.

Pereonite 1 longest. Pereopodal dactyli without secondary ungui, although there is often a small accessory spine at base of unguis. Pereopods I–III: distal superior margins of ischium and merus produced as a spoon-shaped process into which adjacent distal articles fit. Pereopods V–VII with sparse setation; bases without median longitudinal row of setae along outer surface. Penes small.

Pleon of 5 free pleonites; pleonite 1 not concealed by pereonite VII; pleonite 4 encompassing lateral margins of pleonite 5. Pleopod 1 operculate to pleopods 2–5 and indurate; peduncle elongated, longer than wide; endopod elongate and narrow, medial margin straight, thick, and almost bare but with moderately long PMS on distolateral margin; exopod shorter than the endopod, ovate, distal margin with moderately long PMS. Pleopod 2: peduncle scarcely wider than long, rami with long PMS; appendix masculinum arises basally or submedially on endopod. Pleopod 5: endopod without PMS. Pleotelson triangular with serrate posterior margin. Uropodal peduncle with laterally produced angle; medial posterior angle somewhat less produced; endopod with notch on lateral margin.

Remarks.—Until now, only 2 species had been assigned to *Conilera*, *C. cylindracea* (Montagu, 1804) and *C. stygia* Packard, 1900. *Conilera cylindracea* is a European species reported by Richardson (1905) as also occurring in the western North Atlantic. However, the true identity of the specimens reported by Richardson as *C. cylindracea* from North American waters (South Carolina, Mississippi, and Florida) is uncertain. The type material of *C. cylindracea* is from Naples, Italy, and Richardson (1905) reported additional records from England and France. Richardson's (1905) description and figures, taken from Sars (1890), are from Naples specimens, not from the two specimens she claimed to have examined from North America. Hence, the American species has never actually been figured or described. Tattersall (1906) did not acknowledge this species as occurring in North America.

Conilera stygia is a blind form reported only once, from a freshwater well in Monterrey, Nuevo Leon, Mexico. Cole and Minckley (1966) suggested that this species may belong to *Speocirolana*. The original description lacks figures and is inadequate for assessment of its proper generic assignment.

Little has been written on this genus, and the distribution of the known species is rather enigmatic. Specimens have been collected with dredges and trawls to about 300 meters, indicating a benthic habitat. Bate and Westwood (1867) reported collecting *Conilera cylindracea* "feeding together within the orbit of the eye of a whiting, the eyeball of the fish being nearly detached from the surrounding parts." Day (1884) reported that the entrails of a dogfish (*Acanthias vulgaris*) "had been entirely eaten out by [*C. cylindracea*]." He further reported that this species "lives generally on soft and sandy bottoms, hunts in shoals and, when abundant, will drive away the congers and other fish." Biernbaum and Wenner (1993) reported collecting it in baited traps off the coast of South Carolina, in depths of 194–212 m.

World list of species.—

1. *C. cylindracea* (Montagu, 1804). Europe and northwest Atlantic (and perhaps southeastern U.S.A.)
2. *C. stygia* Packard, 1900 (*species inquirenda*). Freshwater wells from Monterrey, Nuevo Leon, Mexico.
3. *C. bullisi* n. sp. Ecuador.

Conilera bullisi n. sp.
Figs. 27–29

Type material examined.—Female holotype (USNM 252745) and 3 paratypes (male, postmanca, manca) (USNM 252746): Ecuador, Gulf of Guayaquil, 3°19' S, 80°43' W, Menzies trawl; Anton Bruun Cruise 18B, Sta. 769-D; 70 m; 10 Sept. 1966.

Description of female.—Cephalon smooth and unornamented, 1.4 times wider than long, somewhat immersed in pereonite 1; eyes small, separated by more than 2 eye-widths (Fig. 27). Antennule short, not reaching posterior margin of cephalon; first article "L"-shaped, second article arising at right angle from article 1; flagellum of about 8 articles; proximal articles wider than long (Fig. 28A). Antennae longer than antennules but barely extending to pereonite 1; flagellum of about 8 articles (Fig. 28B). Mandibular incisor tricuspidate, outer cusp widest, inner cusp longest, middle cusp indented; molar process with short, stout spines along upper margin; spine row well developed with acute spines; palp 3-articulate, middle article longest and with 3 simple setae (Fig. 28D). Maxillule medial lobe with 3 robust, circumplumose apical spines; lateral lobe with 11 stout apical spines (Fig. 28E). Maxilla with plumose setae on medial lobe, simple apical setae on bifurcate lateral lobe (Fig. 28F). Maxillipedal palp 5-articulate; endite reaching middle of palp article 2, with 1 coupling spine (Fig. 28G).

Pereon smooth, not sculptured; pereonites subequal in width; coxal plates not visible in dorsal aspect; in lateral aspect coxal plates II–IV subrectangular, V–VII with acute posterior margins. Pereopods I–III: propodi with 2 spines on inferior margin and

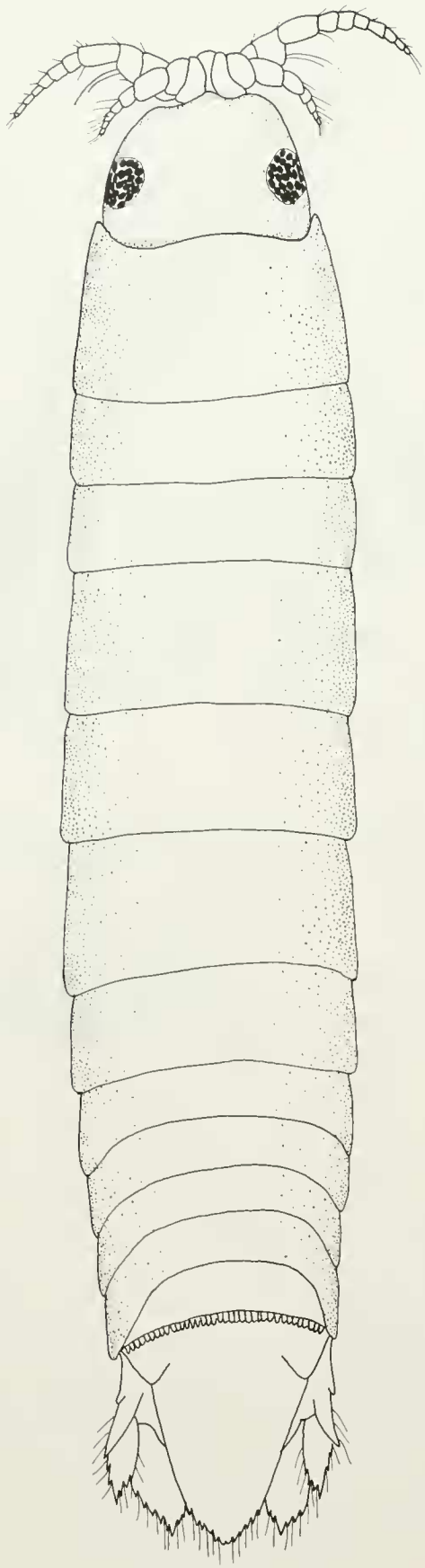

Figure 27. *Conilera bullisi* n. sp. (USNM 252745), holotype, female.

clump of simple setae on superior distal margin; carpus with 1 or 2 spines on inferior margin; merus of pereopod I with 3 blunt and 3 acute spines on inferior margin; merus of pereopod III with only 2 blunt spines; pereopods I–III with 1 blunt spine among setae on produced distal-superior margin of merus; dactyli shorter than propodi, slightly curved (Figs. 29A, B). Pereopod VII: merus with somewhat produced superior distal margin, bearing setae; inferior margin of merus, carpus, and propodus with thin, acute spines, sparsely setose; dactylus about 0.5 times length of propodus (Fig. 29C).

Pleonite 1 longer and wider than subsequent pleonites. Pleonite 5 completely enclosed by pleonite 4; pleonite 5 with a dense row of simple spines on posterior margin (Figs. 27, 29K). Pleopodal rami with PMS as figured (Figs. 29E-I). Pleopod 1: peduncle about 1.4 times longer than wide, with 5 coupling spines inset on medial margin (Fig. 29E). Peduncles of pleopods 2–4 with 3 coupling spines on medial margin. Pleopod 5 without coupling spines. Pleopodal endopods 1–4 with PMS on apical margin, exopods with long PMS on apical and lateral margins. Pleopods 3–5: exopods with notch in lateral margin. Uropodal endopod and exopod margins strongly serrate, with a single PMS arising between each tooth (Fig. 29D); endopod 1.3 times longer than exopod; exopod narrower than endopod; endopod does not extend beyond posterior margin of pleotelson.

Description of male.—Penes small, bean shaped, almost touching (Fig. 29L). Appendices masculinae arise on endopods of pleopods 2 (Fig. 29J). Otherwise similar to female.

Size.—To maximum length of 7 mm.

Distribution.—Known only from the type locality, Gulf of Guayaquil, Ecuador.

Remarks.— *Conilera bullisi* is only the second (the third if *C. stygia* is eventually retained in the genus) species described in this genus, and it is the first *Conilera* species recorded from the Pacific.

Etymology.—This species is named for William Bullis, practitioner of law, adventurer, friend, and surfer par excellence, in deep gratitude for the assistance provided to us for our expeditionary work.

Eurydice Leach, 1815

Type species.—*Eurydice pulchra* Leach, 1815. Type material at BMNH.

Synonymy.—Emended and subsequent to Bruce (1986a:11).

Eurydice. Brusca 1980: 228. Menzies and Kruczynski 1983: 84. Brusca and Iverson 1985: 34. Kensley and Schotte 1989: 147.

Description.—Body 2.5–3.5 times longer than broad; dorsum smooth, without ornamentation. Eyes small to large; ommatidia extend to ventral lateral position on cephalon. Rostrum minute or absent. Frontal lamina narrow, anterior part projecting ventrally, not joined with clypeus; clypeus short, broad, wider than long, with a freely projecting triangular blade; labrum broadly joined to clypeus and slightly narrower than clypeus. Antennule short; peduncle 3-articulate; article 1 longest; article 2 arises at right angle to article 1; proximal flagellar articles typically fused. Antennal peduncle 4-articulate (articles 4 and 5 fused?); article 4 longest. Mandible with broad, tridentate incisor; palp extends well beyond cutting edge; spine row a large, rounded lobe with stout simple spines; middle article of palp longest. Maxillule medial lobe with 3 stout circumplumose spines; lateral lobe with 11–13 stout spines. Maxilla small, simple medial lobe absent or weakly developed. Maxillipedal palp articles 3 and 4 subequal in length and width; endite reduced, failing to reach or barely reaching beyond first palp article, and without coupling spines.

Pereonites 1 and II subequal in length. Coxae II–VII with posteroventral angles becoming increasingly acute posteriorly. Pereopods I–III short, grasping, spinose, with distal superior margins of ischium and merus more or less produced. Pereopods IV–

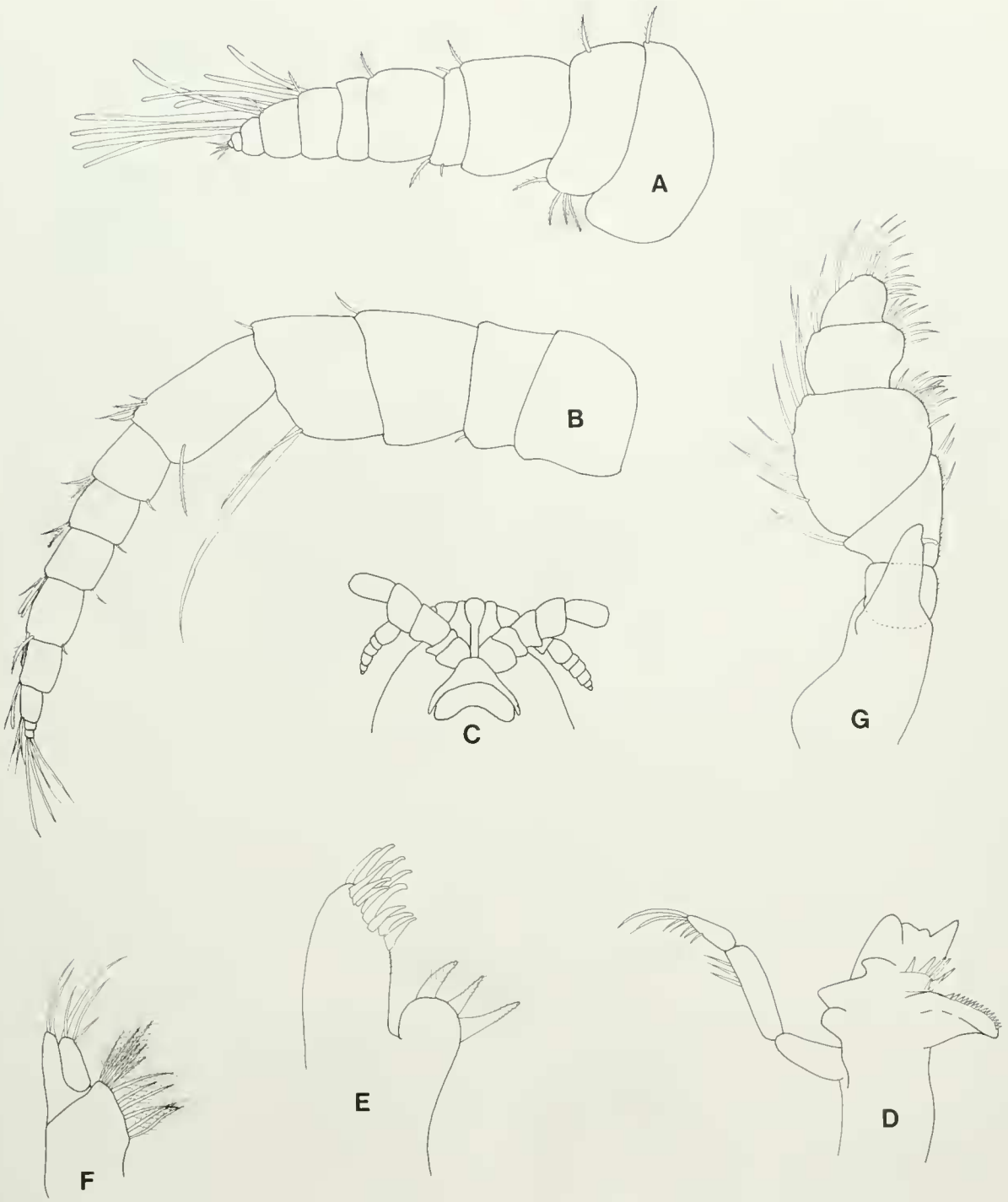

Figure 28. *Conilera bullisi* n. sp. (USNM 252745), holotype, female: A, antennule (left). B, antenna (left). C, frontal lamina, clypeus, and labrum. D, mandible (left). E, maxillule (left). F, maxilla (left). G, maxilliped (left).

VII long, spinose, setose; ischium–propodus flattened. Penes large, well developed, 1.5–3.5 times longer than broad, lobes somewhat flattened.

Pleon of 5 free pleonites; pleonite 5's lateral margins not overlapped by pleonite 4. Peduncles of pleopods 1–5 wider than long, pleopod 1's peduncle subquadrate. Pleopods rounded, only endopod of pleopod 5 lacking setae; appendix masculina inserted medially or submedially on endopod on male's pleopod 2. Pleopod 5: peduncle without coupling spines or plumose setae on medial margin; endopod with proximomedial margin produced, lobelike. Pleotelson with apex rounded, truncate, or subacute, usually emarginate; dorsum with anteromedial depression. Uropodal peduncle with inner angle not greatly produced, with row of PMS on lateral margin; exopod lateral margin without PMS.

Remarks.—Species in this genus are superficially similar in appearance to those of *Cirolana* and *Anopsilana* but may be

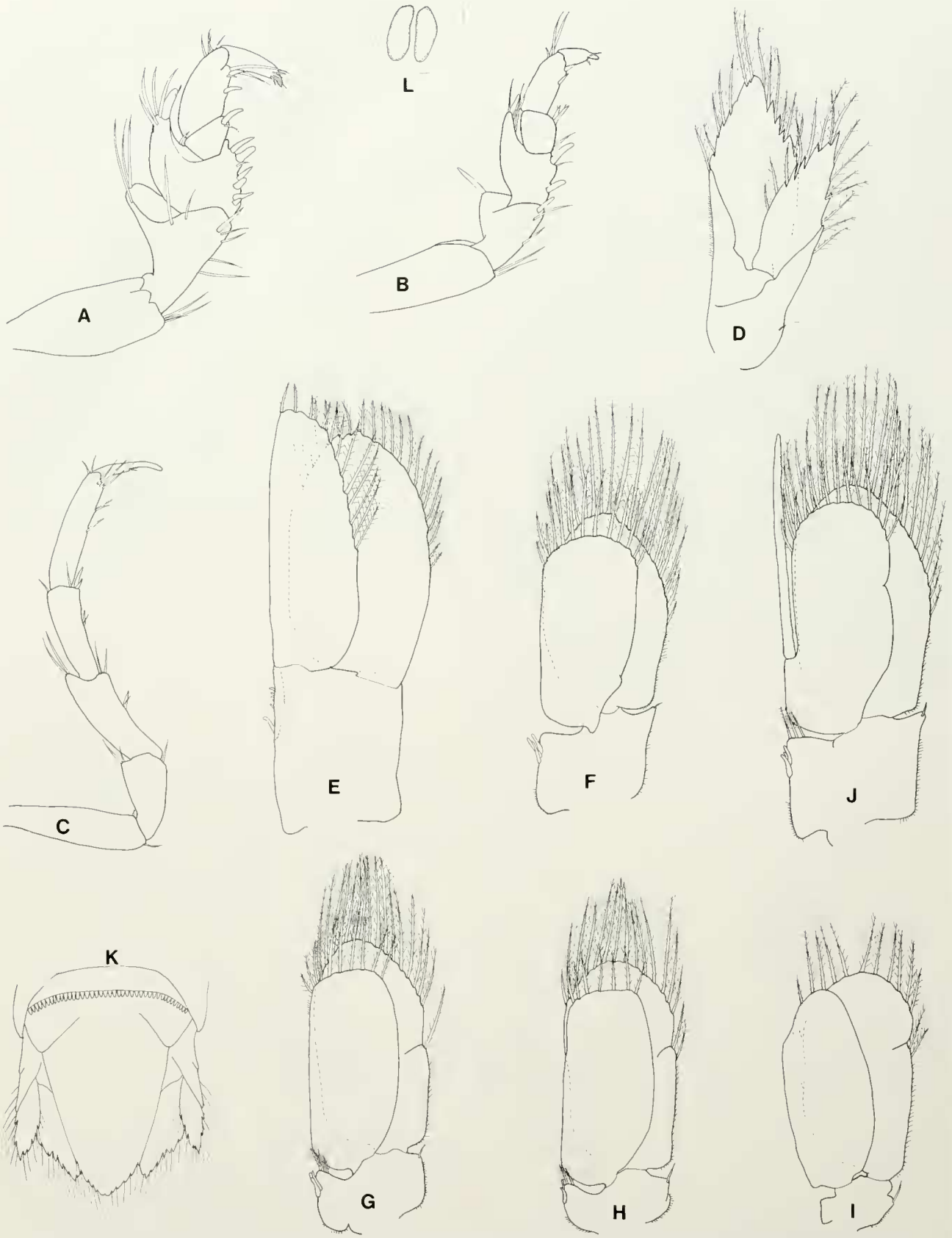

Figure 29. *Conilera bullisi* n. sp. (USNM 252745), holotype, female (except J, L, paratype, male): A, pereopod I. B, pereopod III. C, pereopod VII. D, dorsal view of uropod. E, pleopod 1. F, pleopod 2. G, pleopod 3. H, pleopod 4. I, pleopod 5. J, pleopod 2 of paratype male (USNM 252746). K, dorsal view of pleonite 5 and pleotelson. L, penes of paratype male (USNM 252746).

quickly distinguished by the unique morphology of the antennular peduncle (the right-angle relationship between articles 1 and 2), the fused basal articles of the antennular flagellum, the 4-articulate antennal peduncle, the reduced maxillipedal endite and absence of coupling spines, the large penes, and characters of the pleotelson and uropods. Bruce (1986a) discussed sexual dimorphism in this genus.

Eurydice also shares some features with *Metacirolana*, another cirolanid genus present in the tropical eastern Pacific. Characters common to both genera include the short first pereonite (subequal in length to pereonite II), all pleonites being free, prominent penes, and a projecting clypeus.

Eurydice is a cosmopolitan genus containing approximately 46 described species. Soika (1955) proposed the subgenus *Pelagonice* for the pelagic species lacking pleotelsonic spines. Like Bruce (1986a) and Jones and Naylor (1967), we doubt that this subgenus is monophyletic or has any systematic utility.

Only a single species of *Eurydice* (*E. caudata*) is known from the tropical eastern Pacific. Its ecology has not been studied. Eleftheriou and Jones (1976) have reviewed the ecology and systematics of the Indian Ocean species; Jones (1974) discussed the ecology of Saudi Arabian species; Soika (1955), Singarajah (1966), Knight-Jones and Qusim (1967), Jones and Naylor (1970), Jones (1968, 1970a, 1970b), Salvat (1966), Fish and Fish (1972), Alheit and Naylor (1976), Hastings and Naylor (1980), Hastings (1981a, 1981b), and Tully and O'Ceidigh (1986) have all reported on the ecology of European species; Bruce (1986a) discussed the Australian species; and DeRuyck et al. (1991) reported on South African species. It appears that most species are predators and/or carnivorous scavengers, and most prefer intertidal and shallow subtidal habitats, where they maintain endogenous circadian activity rhythms. Bruce (1986a) noted that there are no intertidal species of *Eurydice* in Australia, all eight Australian species being exclusively subtidal. The eastern Pacific species, *E. caudata*, is most commonly collected by night lighting in shallow water.

World list of species.—

1. *E. acuticauda* Bruce, 1981. Victoria, Australia.
2. *E. affinis* Hansen, 1905. Northeast Atlantic and Mediterranean.
3. *E. agilis* Jones, 1971. Kenya.
4. *E. akiyamai* Nunomura, 1981. Central Japan.
5. *E. arabica* Jones, 1974. Red Sea.
6. *E. bathypelagica* Schultz, 1977. Subantarctic. *Incertae sedis* according to Bruce (1986a).
7. *E. binda* Bruce, 1986. New South Wales, Australia.
8. *E. caeca* Hansen, 1916. North Atlantic. *Incertae sedis* according to Bruce (1986a).
9. *E. caudata* Richardson, 1899. Southern California to Ecuador.
10. *E. cavicaudata* Jones, 1971. Kenya.
11. *E. chelifer* Jones, 1971. Kenya.
12. *E. clymeneia* Monod, 1926. Morocco.
13. *E. convexa* Richardson, 1900. Florida.
14. *E. czerniavsky* Bacescu, 1948. Mediterranean.
15. *E. dollfusi* Monod, 1930. Adriatic, Mediterranean, and Black seas.
16. *E. elongata* Moreira, 1972. Brazil.
17. *E. emarginata* Moreira, 1972. Brazil.
18. *E. grimaldii* Dollfus, 1888. Northeast Atlantic.
19. *E. humilis* Stebbing, 1910. Maldives.
20. *E. indicis* Eleftheriou and Jones, 1976. Southwestern India.
21. *E. inermis* Hansen, 1890. Atlantic and Mediterranean coasts of Europe.
22. *E. inornata* Jones, 1971. Kenya.
23. *E. littoralis* (Moore, 1902). Atlantic coast, from North America to Brazil.
24. *E. longiantennata* Nunomura and Ikehara, 1985. Sea of Japan.
25. *E. longicornis* (Studer, 1883). Namibia.
26. *E. longipes* Jones, 1971. Kenya.
27. *E. longispina* Jones, 1969. Mediterranean.
28. *E. mauritanica* DeGrave and Jones, 1991. Mauritania.
29. *E. minya* Bruce, 1986. Australia.
30. *E. nipponica* Bruce and Jones, 1981. Japan.
31. *E. orientalis* Hansen, 1890. Australia, Philippines, Indonesia, Papua New Guinea, Sri Lanka, and Indo-China.
32. *E. peraticis* Jones, 1974. Red Sea to western India.
33. *E. personata* Kensley, 1987. South Carolina to Florida, Greater Antilles, Turks and Caicos, and Venezuela.
34. *E.piperata* Menzies and Frankenberg, 1966. Georgia to Gulf of Mexico.
35. *E. pontica* (Czerniavsky, 1868). Black Sea and Mediterranean.
36. *E. pulchra* Leach, 1815. Atlantic coast of Europe and North Africa.
37. *E. racovitzae* Bacescu, 1949. Mediterranean.
38. *E. rotundicauda* Norman, 1906. Eastern North Atlantic and Mediterranean.
39. *E. spenceri* Bruce, 1981. South Australia.
40. *E. spinigera* Hansen, 1890. Atlantic and Mediterranean coasts of Europe.
41. *E. subtruncata* Tattersall, 1921. New Zealand.
42. *E. tarti* Bruce, 1986. Victoria, Australia.
43. *E. truncata* (Norman, 1868). Eastern North Atlantic and Mediterranean.
44. *E. valkanovi* Bacescu, 1949. Black Sea.
45. *E. woka* Bruce, 1986. Queensland, Australia.
46. *E. wyuna* Bruce, 1986. Queensland, Australia.

Eurydice caudata Richardson, 1899
Figs. 30–34

Eurydice caudata Richardson, 1899a: 824; 1899b: 164; 1900: 217; 1901: 516; 1905: 124. Steinbeck and Ricketts 1941: 424. Schultz 1969: 173. Bowman 1977: 654. Brusca 1980: 228. Brusca and Iverson 1985: 34. Bruce 1986a: 221.

Eurydice branchuropus Menzies and Barnard, 1959: 32. Schultz 1966: 14; 1969: 173.

Type material examined.—Syntypes (USNM 22565): U.S.A., California, Santa Catalina Island, Isthmus Cove; R/V *Albatross*; 6 Apr. 1897; 20 specimens.

Other material examined.—California specimens: (2) Monterey Co., Pacific Grove, in compound tunicate mass; LACM/AHF [no catalog number]; 1 Apr. 1929; 5 specimens; (3) Los Angeles Co., Santa Catalina Island, Emerald Cove, 33°28' N, 118°31' W, 27.5 m, among school of squid copulating under night light; R/V *Velero IV* Sta. 2047-51, LACM; 27 July 1951; 1 specimen; (4) Los Angeles Co., Santa Catalina Island, off Howland's Landing, 40 m; R/V *Velero* Sta. 2141-52, AHF Cat. No. 770-01, LACM; 6 Aug. 1952; 1 specimen; (5) San Diego Co., La Jolla, Scripps Pier; No. H46-63, SDNHM; 2 specimens. Pacific Baja California specimens: (6) Guadalupe Island (south end), Melpomene Cove, taken at night with light; AHF [no catalog number]; 27 Jan.–3 Feb. 1950; coll. C. Hubbs and party; 31 specimens; (7) San Benito Islands; R/V *Albatross* Sta. 5767, USNM 69719; 9 Mar. 1911; 20 specimens.

Gulf of California specimens: (8) Sonora, San Jorge Island, anchorage off west side, dip net under night light; UA 72-60, SDNHM A.0146; 10 Dec. 1972; 25 specimens; (9) Baja California (Norte), Puertecitos; 13 Apr. 1973; SDNHM A.0068; coll. D. Dexter; 30+ specimens; (10) Sonora, Tiburon Island, Risco Colorado Point, on *Sargassum* at night with light, 10 m; HC-10-III-1985, SDNHM; 10 Mar. 1985; coll. H. Chaney; 50+ specimens; (11) Baja California, Las Animas Island, on sand, 17 m; AHF Cat. No. 1282-02, LACM; 9 Sept. 1978; coll. A. Kerstitch; 20+ specimens; (12) Baja California, San Francisquito Bay, taken with electric light; R/V *Albatross* Sta. A5767, USNM 69720; 1911; 15+ specimens; (13) Baja California, San Pedro Nolasco Island, surface, by dip net just after dark; AHF Cat. No. 1997-1, LACM; 28

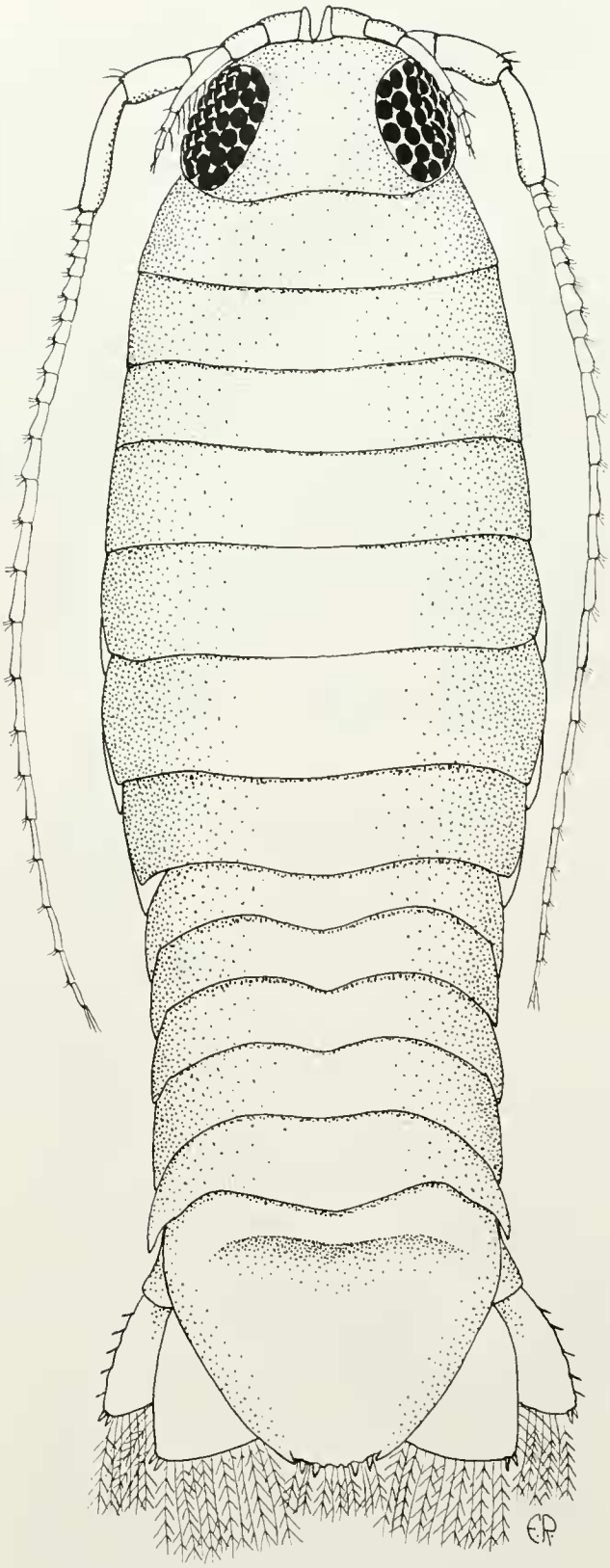

Figure 30. *Eurydice caudata* (USNM 22565), syntype, male.

June 1976; coll. M. Gilligan; 11 specimens; (14) Sonora, San Carlos Bay; Acc. 160366, USNM 86346; 30 Mar. 1940; coll. E. F. Ricketts; 15 specimens; (15) Sonora, San Carlos Bay, "pelagic haul," light over side at anchorage; Acc. 160366, USNM 86342; 30 Mar. 1940; coll. E. F. Ricketts; 30+ specimens; (16) Baja California, Tortuga Island; 12 Mar. 1936; night light; USNM Acc. No. 139772; 300+ specimens (in 3 vials); (17) Baja California, S. of Tortuga Island, 27°24'50" N, 111°53'35" W, 137 m, sand; R/V *Velero III* Sta. 695-37; 17 Mar. 1937; 50+ specimens; (18) Baja California, Concepcion Bay, light over side at anchorage; USNM 86343; 28 Mar. 1940; coll. E. F. Ricketts; 25 specimens; (19) Baja California, 1 mi. off Pulpito Point, taken at night with dip net and night-light, 2115–2215 hrs.; LACM; 22 June 1976; coll. R. H. Behrstock; 1 specimen; (20) Baja California, Puerto Escondido (across from Carmen Island), 25°48' N, 11°18' W, 31 m, taken with night light at 0900 hrs.; R/V *Velero IV* Sta. 1751-49, LACM; 19 Mar. 1949; 17 specimens; (21) Baja California, Carmen Island, taken with electric light; R/V *Albatross* Sta. A5767, USNM 69718; 1911; 20+ specimens; (22) Baja California, Carmen Island, Salinas Bay; SDNHM; 14 May 1939; coll. R. W. Mindte, M/S *St. Mary*; 500+ specimens; (23) Baja California, Agua Verde Bay, with electric light; R/V *Albatross* Sta. A5767, USNM 69722; 15+ specimens; (24) Baja California, Agua Verde Bay near Marcial Point, 25°31' N, 111°04' W, night light off ship, 2200 hrs.; R/V *Velero IV* Sta. 1741-49, LACM; 16 Mar. 1949; 50+ specimens; (25) Baja California, off Marcial Point, "pelagic," 24 m, at anchorage, 2200 hrs.; Acc. 159124, USNM 86337; 24 Mar. 1940; coll. E. F. Ricketts; 100+ specimens; (26) Sinaloa, Topolobampo, 25°36' N, 109°04' W; SDNHM A.0068; 8 July 1972; coll. D. Dexter; 4 specimens; (27) Baja California, San Jose Island, Ostiones Point, night, at 10 m on algae; HC-25-II-1985, SDNHM; 25 Feb. 1985; coll. H. Chaney; 150+ specimens; (28) Baja California, San Jose Island, taken with electric light; R/V *Albatross* Sta. A5767, USNM 69724; 1911; 10 specimens; (29) Baja California, San Francisco Island, east coast, taken at night, over 18 m bottom with red and green algae, sand, and *Excirolana* sp.; HC-24-II-1985, SDNHM; 24 Feb. 1985; coll. H. Chaney; 100+ specimens; (30) Baja California, San Francisco Island, S.W. cove, surface; R/V *Velero III*, LACM; 5 May 1932; 1 specimen; (31) Baja California, Inner Gorda Bank, off San Jose del Cabo, dredge, 128-143 m; R/V *Velero IV* 1135-40, LACM; 20 Jan. 1940; 1 specimen; (32) Baja California, Cape San Lucas; R/V *Albatross* Sta. A5767, USNM 69723; 1911; 30+ specimens; (33) Baja California, Cape San Lucas, "pelagic," with night light; USNM 86344; 29 Mar. 1940; coll. E. F. Ricketts; 4 specimens.

Central eastern Pacific specimens: (34) Mexico, Jalisco, Tenacita Bay, 25°58' N, 113°08' W, shore and land collecting; R/V *Velero III* Sta. 2-33, LACM; 3 Jan. 1933; 1 specimen. (35) Costa Rica, Cocos Island, on fish; USNM Acc. 122445; coll. W. L. Schmitt; 1 specimen. (36) Costa Rica, Cocos Island, Chatham Bay; Acc. 148787, USNM 86345; 3 Aug. 1938; coll. W. L. Schmitt; 2 juveniles. (37) Costa Rica, Cocos Island, Chatham Bay, 5°33.3' N, 87°02.63' W, *Porites* reef, 12–15 m; CRC-88-1, LACM 88-7; coll. R. W. Peck and H. G. Kuck; 10 specimens. (38) Ecuador, La Libertad; R/V *Velero III* Sta. 13-33, LACM; 19 Jan. 1933; 3 specimens. (39) Isabel Island, "21°52' N, 102°51' W," taken at anchorage with electric light; AHF 748-37, LACM; 10 specimens [coordinates evidently in error].

Description of male.—Cephalon width 3.2 times length; anterior margin of cephalon evenly rounded, without rostral point. Eyes large and well developed (Fig. 30). Antennule short, barely reaching posterior margin of cephalon, flagellum with a large basal piece comprising numerous fused articles and aethestasc bundles and 3 free articles (Figs. 31A, B, 32A). Antenna very long, usually reaching to pereonite VII, occasionally to pleotelson (Fig. 33A); flagellum of 20–25 articles, distal articles 3–4 times longer than broad (Fig. 32B). Frontal lamina greatly elongated, posteriorly acute

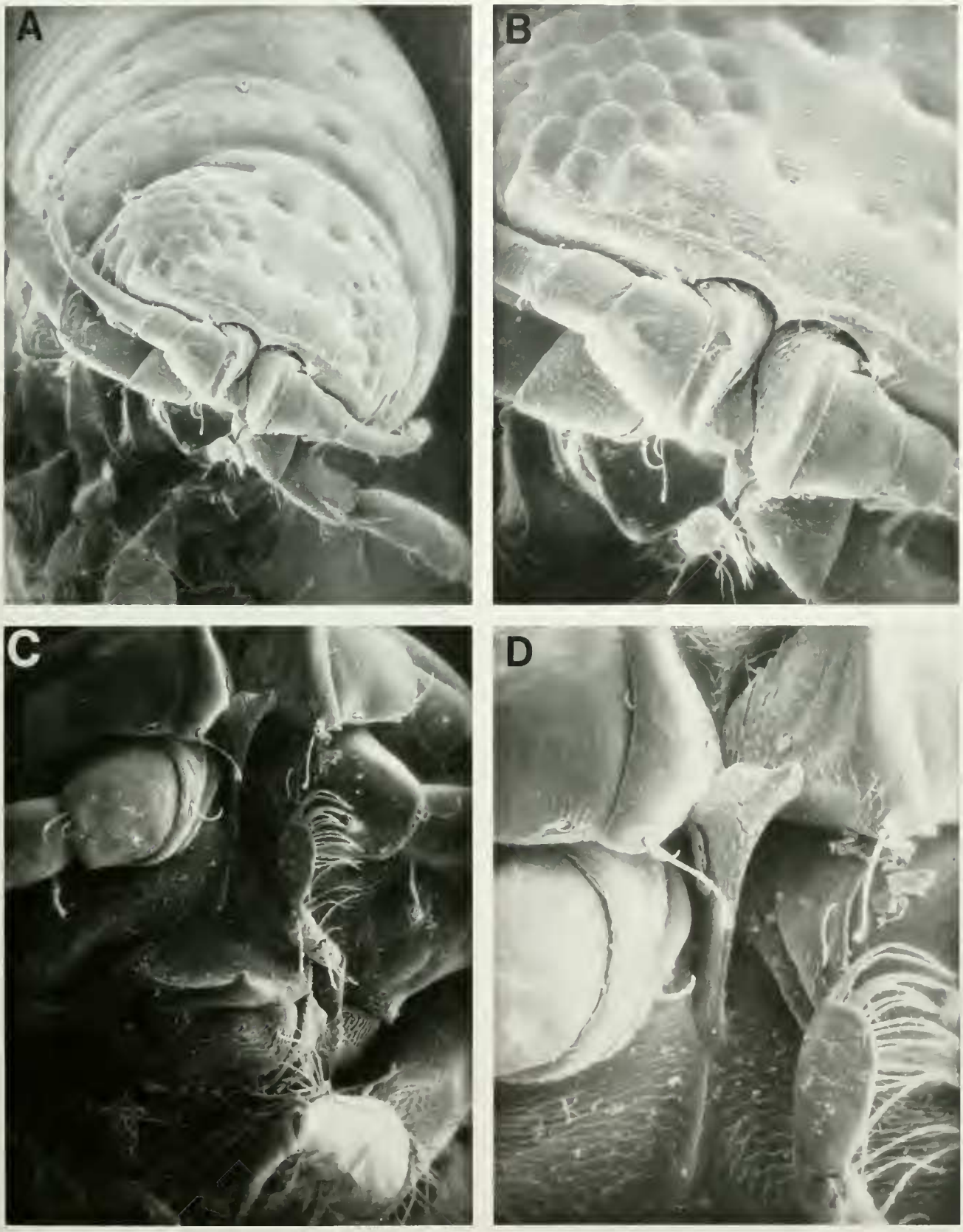

Figure 31. *Eurydice caudata* (LACM specimens from Mexico, Sonora, Tiburon Island, coll. H. Chaney, 10 Mar. 1985), scanning electron micrographs: A, anterior view of cephalon and antennules, 50×. B, detail of antennule peduncle, 100×. C, frontal lamina, clypeus, and labrum, 100×. D, frontal lamina, 200×.

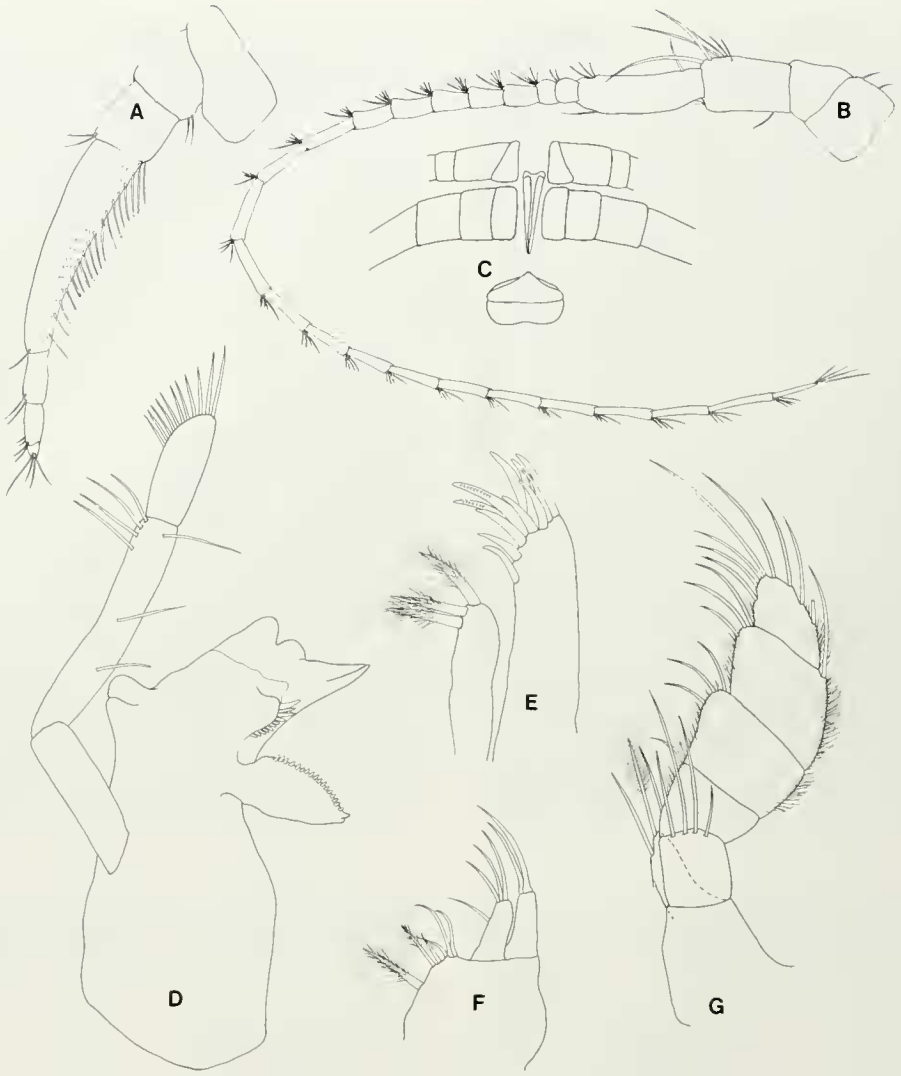

Figure 32. *Eurydice caudata*, A, B, USNM 22565 syntype, male, C–G, AHF 770-01, male: A, antennule. B, antenna. C, frontal lamina, clypeus, and labrum. D, mandible. E, maxillule. F, maxilla. G, maxilliped.

(Figs. 31C, D, 32C); posterior margin of labrum rounded. Mandibular spine row forms a rounded lobe with 5–11 simple spines; molar process with 16–18 acute marginal spines; middle palp article with 7 simple setae, distal article with 11 simple setae as figured (Fig. 32D). Maxillule lateral lobe with 11 large simple spines, 2 with small distal barbs (Fig. 32E). Maxilla medial lobe with 2 plumose setae and 4 simple setae; lateral lobes with 4 and 2 simple setae, respectively (Fig. 32F). Maxillipedal endite with 1 plumose seta and 2 simple setae; palp articles with marginal simple setae and hairs as figured (Fig. 32G).

Pereon widest at pereonites IV–VI. Coxal plates V–VII visible in dorsal view; posterior angle of coxa VI elongate and narrowed, extending nearly to posterior margin of coxa VII; posterior angle of coxa VII not elongate and narrowed but rather blunt (Fig. 30). Pereopod 1 short, distal superior margin of merus and ischium weakly produced (not strongly produced as in *Natatolana*); distal superior and inferior margins of basis with a few long simple setae; inferior margin of ischium with row of simple setae, distal superior margin with 1 large spine and several simple setae; superior distal angle of merus with 4–8 long simple setae, inferior margin with 3 short blunt spines and several simple setae; inferior distal angle of carpus with 1 blunt spine and several setae; propodus long, more than twice length of dactylus, superior margin with numerous long simple setae, inferior margin with 3 kinds of setae, simple, comb, and serrate, and 1 large stout spine at distal angle; dactylus with 1 comb seta and several short simple setae spine at base of unguis lacking (Fig. 34A). Pereopod IV short; ischium–propodus with large stout spines on superior and inferior margins as figured; without spine at base of unguis (Fig. 34B). Pereopod VII long; merus, carpus, and propodus flattened, longer than broad, and wider than propodus; with many simple setae and spines as figured (Fig. 34C). Penes 1.5–2.0 times longer than broad, rounded apically, with a "joint" or fold about quarter distance from base, set close together, and separated by 1 minute simple seta (Figs. 33B, 34D).

Pleon elongate, nearly as wide as pereon. Pleonite 5's posterolateral margins slightly produced (Fig. 30). Pleopodal rami with PMS as figured (Figs. 34F–J). Pleopod 1 smaller than pleopods 2–5; medial margin with 4 coupling spines and 2 plumose setae; endopod

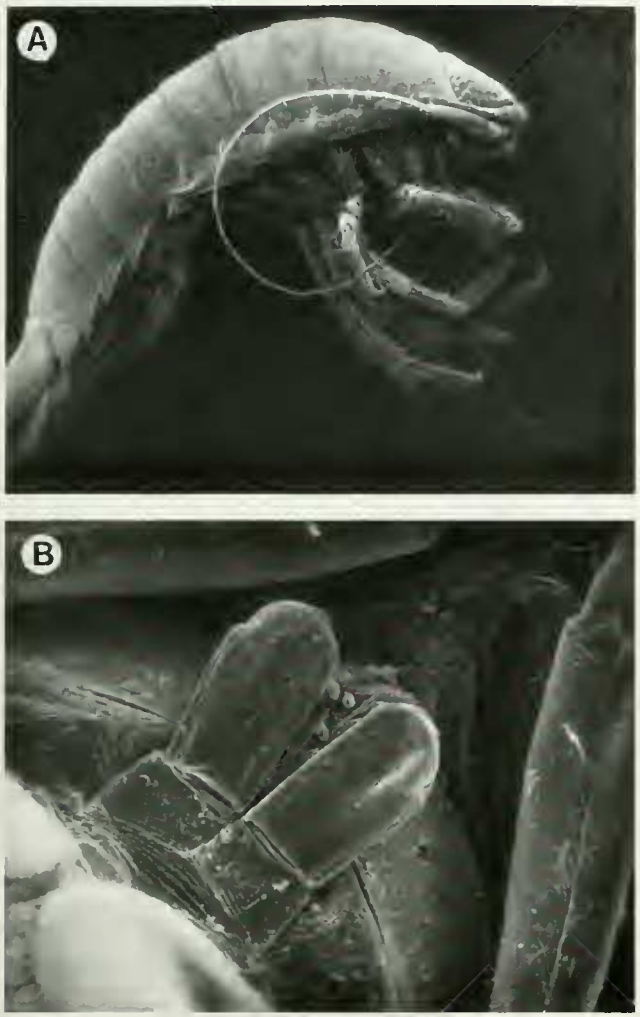

Figure 33. *Eurydice caudata* (LACM specimens from Mexico, Sonora, Tiburon Island, coll. H. Chaney, 10 Mar. 1985), scanning electron micrographs: A, lateral view, 15×. B, ventral view of penes on sternite VII, 89×.

0.78 times width of exopod, lateral (outer) margin concave (Fig. 34F). Pleopod 2: peduncle's medial margin with 3 coupling spines and 2 plumose setae, lateral margin with 1 simple seta; endopod width 0.92 times exopod width; appendix masculina widening subapically, scythe-shaped, length 1.19 times length of exopod (Fig. 34G). Pleopod 3: peduncle's medial margin with 3 coupling spines and 2 plumose setae, lateral margin with 1 simple seta; endopod width 0.89 times width of exopod; exopod with complete medial incision (Fig. 34H). Pleopod 4: peduncle's medial margin with 3 coupling spines and 1 plumose seta, lateral margin with 1 simple seta; endopod width 0.73 times exopod width; exopod with complete medial incision (Fig. 34I). Pleopod 5: endopod width 0.69 times exopod width; exopod with complete medial incision (Fig. 34J).

Pleotelson broadly rounded, wider than long, lateral margins convex; apex truncate, with shallow transverse indentation set off by acutely produced corners; indentation with PMS and 4 short simple spines. Pleotelson dorsum with shallow depression near base, without carinae or tubercles (Fig. 30). Uropodal peduncle not visible dorsally; lateral margin fringed with long PMS. Uropodal rami do not extend beyond pleotelson apex; rami without apical notches; fringed with long PMS distally; outer distal angle of each ramus with 2–3 small spines. Uropodal endopod 1.4 times exopod width, distal lateral margins slightly rounded (Fig. 34E).

Female.—Similar to male, although antennal flagella may be somewhat shorter than in males and pleon may be slightly narrower than pereon.

Ultrastructural features.—When viewed with SEM, the surface of the body and appendages has a scalelike cuticular structure. The body dorsum has many cuticular sensillae set inside small pits (Fig. 31A).

Size.—Small, to maximum length of 9 mm.

Distribution.—*Eurydice caudata* ranges from southern California to the Gulf of Guayaquil, Ecuador, including the islands of Guadalupe, Revillagigedos, Tres Marias, and Cocos. It is apparently common throughout its range, both in the warm temperate Californian Province and in the tropics. The northernmost record (Pacific Grove, California), the only one north of the California Province, seems to be an anomaly. The southernmost record is for La Libertad, Ecuador (on the north shore of the Gulf of Guayaquil). This species is very common throughout the Gulf of California. Its depth range, based on the material we have examined, is from the low intertidal region to 160 m; most records are from 0 to 50 m depth.

Remarks.—*Eurydice branchuropus* was described from southern California by Menzies and Barnard (1959) but reduced to a synonym of the Atlantic species *E. littoralis* (Moore) by Menzies and Glynn (1968). Bowman (1977), however, removed *E. branchuropus* from *E. littoralis* and placed it in synonymy with *E. caudata*.

Eurydice caudata is most often taken by night-lighting off ships anchored over shallow soft bottoms. In California and western Mexico we have collected it regularly from coarse sands and silts, at depths of 5 to 160 m.

Excirolana Richardson, 1912

Type species.—*Cirolana orientalis* Dana, 1853, from the Sulu Sea, by original designation (Richardson 1912). Location of type material unknown; specimens possibly lost when the sloop "Peacock" sank off the mouth of the Columbia River (Bruce 1986a).

Synonymy.—Emended and subsequent to Bruce (1986a:39).

Excirolana. Brusca 1980: 227. Jones 1983: 309. Brusca and Iverson 1985: 31. Kensley and Schotte 1989: 149.

Pontogeloides Barnard, 1914: 355.

Description.—Body 2.5–3.0 times longer than broad; dorsum evenly convex and unsculptured; pereonite 1 almost always longer than pereonite II. Eyes moderate in size. Posterior region of cephalon often with lateral incisions; cephalon with prominent rostrum; in all but three described species the rostrum is strongly dilated distally as a spatulate process separating antennules (only moderately dilated in *E. monodi* and *E. hirsuticauda*); rostrum confluent with (or fused to) frontal lamina. Frontal lamina varies from narrow and linear to somewhat wide (but always longer than wide); clypeus short, wider than long, subtriangular, weakly projecting, narrower than labrum; labrum broad. Antennular peduncle 3-articulate, but articles 1 and 2 are fused in many species; article 3 never as long as 1 and 2 combined; flagellum may vary in length with age, but always longer than peduncle; basal flagellar articles longer than wide. Antennal peduncle 4- or 5-articulate; if 5-articulate, article 5 never as long as 1–4 combined. Mandible with broad tridentate incisor, quadridentate on left mandible in many species; 2- or 3-articulate palp extends beyond incisor's cutting edge; spine row and molar process well developed; spine row lobelike, with numerous long, acute, flexible spines. Maxillule medial lobe with 3 stout circumplumose setae and occasionally 1 or 2 smaller circumplumose setae; lateral lobe with several to many stout simple spines (often barbed). Maxilla medial lobe moderately developed and setose, with bifurcate lateral lobe well developed, with many long simple setae. Maxilliped slender, palp of 5 articles, article 3 wider than 4; endite with 1 coupling spine.

Figure 34. *Eurydice caudata*, A–C, USNM 22565 syntype, male, D–I, AHF 770-01, male: A, pereopod I. B, pereopod IV. C, pereopod VII. D, penes. E, dorsal view of uropod (inset: details of apices). F, pleopod 1. G, pleopod 2. H, pleopod 3. I, pleopod 4. J, pleopod 5.

Pereopods all ambulatory; I–III grasping; bases of V–VII narrow, not markedly flattened; all legs usually bear spines on the propodus, carpus, merus, and ischium; pereopods often with large accessory spine at base of ungui. Penes well developed on sternite of pereonite VII.

Pleon of 5 free pleonites; pleonite 1 may be largely or partly hidden by pereonite VII; pleonite 5 as wide as 4, with lateral margins not overlapped (or only partly overlapped) by 4. Pleopods with elongate rami; pleopod 1 not indurate or operculate; pleopods 1 and 2 generally similar, with PMS on both rami; exopods of pleopods 3–

5 with PMS, endopods of 3–5 (or 2–5) without PMS; appendix masculina of male arises basally or submedially on margin of endopod of pleopod 2. Pleopodal peduncles 1–4 with coupling spines and plumose setae on medial margins and usually on accessory lobes on lateral margins; pleopodal peduncle 5 without coupling spines. Pleotelson apex subacute or rounded, never indented or excavated; with or without spines, but always with PMS. Dorsum of pleotelson with 2 shallow submedian depressions, one either side of midline (in some species these pits are prominent, in others they are shallow and difficult to discern). Uropodal peduncle's inner angle not produced or only modestly produced, never long and acute; rami usually extend to or beyond posterior border of pleotelson; exopod equal to or longer than endopod; medial distal margins of uropodal exopod and often endopod usually with stout spines and PMS, outer margins without spines in most species (present in some); lateral margin of endopod usually with a small marginal pit.

Remarks.—Bruce (1986a) felt that the genus *Excirolana* was difficult to describe and lacked constant morphological features. He also noted the unsettled synonymy of *Excirolana* with *Pontogeloides* (see Monod 1930, 1933; Jones 1971; Carvacho 1977). Some authors have regarded *Pontogeloides* as a subgenus of *Excirolana* (Monod 1930, 1931; Nierstrasz 1931). There seems to be no compelling reason to maintain *Excirolana* and *Pontogeloides* as separate genera, and we agree with Bruce that the latter is a junior synonym of the former. Only the presence of naked endopods on pleopod 2 distinguishes *Pontogeloides*.

There are two synapomorphies unambiguously defining *Excirolana* (including *Pontogeloides*). First is the prominent rostral process, which is apically dilated and usually spatulate—it is confluent with (or indistinguishably fused to) the frontal lamina. The rostrum separates the antennules, and the frontal lamina separates the antennae. Second, the genus is ovoviviparous, with enlarged oviducts serving as uteri and with reduced oostegites. (However, internal brooding also occurs in *Annina*; see below). In addition to these two attributes, there are two other, nearly consistent features of the genus. First, the lateral margin of the uropodal endopods usually bears a small pit or notch. This structure is often difficult to see through the light microscope, and it is impossible to judge from the literature if it occurs in all species, but we suspect that it does. In some species (e. g., *E. hirsuticauda*) the pit manifests itself as a minute marginal pocket, flush with the margin of the endopod and very difficult to see; in others (e. g., *E. brazilienisis*) it forms a deep obvious notch in the endopod margin. The function of this curious pit is unknown. Second, almost all species have distinct paired submedian depressions on the dorsum of the pleotelson—these appear to be poorly developed or wanting in at least *E. hirsuticauda* and *E. latipes*.

These four features, in combination with those listed in the general description, unambiguously distinguish this genus. Menzies (1962a) claimed that the rostrum of *E. hirsuticauda* was acute, not expanded. However, his own illustrations of this species, and our examination of specimens from Chilean sand beaches, indicate that the rostrum is indeed expanded, albeit weakly. We also note that numerous authors have mistakenly referred to the rostrum in *Excirolana* as the "frontal lamina."

The genus *Annina* is very similar to *Excirolana*. Both *Annina lacustris* Budde-Lund, 1908 (= *Excirolana bowmani* Jones and Iceley, 1981) and *A. kumari* (Bowman, 1971) (= *Excirolana kumari* Bowman, 1971) have previously been assigned to *Excirolana*, and Messana (1984) suggested that *Excirolana* should be considered a junior synonym of *Annina*. However, as Jones (1983) and Bowman and Iliffe (1991) pointed out, several features of *Annina* clearly distinguish it from *Excirolana*. In *Annina*, the eyes are divided into dorsal and ventral parts by a nonfaceted gap, article 3 of the antennule is always as long as or longer than articles 1 and 2 combined, article 5 of the antenna is equal to or longer than articles 1–4 combined, pleonites 1 and 2 are narrower than 3–5 and covered laterally by the coxal plates of pereonites VI and VII, the uropods have a strongly produced mediodistal angle, the cephalon or pereonites of males bear prominent dorsal horns, and the characteristic spatulate rostrum and uropodal endopod notch of *Excirolana* are apparently wanting. However, the two genera are probably closely related. Their being the only two cirolanid genera known to brood internally suggests that they might be sister groups, although the precise nature of the brood pouch in *Annina* has yet to be described.

So far as is known all species of *Excirolana* are ovoviviparous, with the eggs retained and the embryos brooded in enlarged paired oviducts functioning as uteri. Females of at least some species develop small, reduced oostegites, although gravid and oostegite-bearing females are rare in collections. The oostegites in some may be rather large (in *E. mayana* they meet in the midline). Oostegites, when present, are easily overlooked because they lie tightly pressed against the sternum.

Brusca and Iverson (1985) briefly summarized the natural history of *Excirolana*. A characteristic that has been occasionally noted in the literature is the ability of some species to inflict a painful bite, especially on swimmers' thin skin. We have been bitten on many occasions by *E. mayana*, a voracious species that often emerges in high numbers near shore. Most species of *Excirolana* are tropical. Bally (1983) studied the respiratory activity of *E. natalensis*, a southern African species inhabiting both temperate and tropical shores. DeRuyck et al. (1991) documented endogenous circadian rhythms in two South African species.

Three species of *Excirolana* occur in the tropical eastern Pacific: *E. braziliensis*, *E. mayana*, and *E. chamensis*. *Excirolana salvadorensis* Schuster, 1954, and *E. koepckei* Bott, 1954, were synonymized with *E. braziliensis* by Glynn et al. (1975), a synonymy that we first doubted but after a lengthy analysis of several hundred specimens finally came to concur with. In addition, 2 species are known from the temperate northeast Pacific: *E. linguifrons* and *E. chiltoni* [= *E. kincaidi* (Hatch, 1947); = *E. vancouverensis* (Hatch, 1947); = *E. japonica* Richardson, 1912]. Three species have been reported from the temperate southeast Pacific: *E. chilensis*, *E. hirsuticauda*, and *E. monodi*. Bruce (1986a) listed 12 species worldwide, overlooking *E. carangis* and *E. hirsuticauda*, inadvertently attributing authorship of *E. chilensis* to Menzies, and omitting *E. mayana* and *E. braziliensis* from the eastern Pacific fauna. Menzies (1962a) incorrectly noted the type species as *Excirolana chilensis*.

World list of species.—

1. *E. affinis* (Jones, 1971). Kenya.
2. *E. armata* (Dana, 1853). Argentina and Brazil.
3. *E. bicornis* Kensley, 1978. South Africa.
4. *E. braziliensis* Richardson, 1912. Caribbean to Brazil; tropical eastern Pacific.
5. *E. chamensis* Brusca and Weinberg, 1987. Panama.
6. *E. chilensis* Richardson, 1912. Chile.
7. *E. chiltoni* (Richardson, 1905). Japan, Taiwan, Hong Kong; in eastern Pacific, British Columbia to California.
8. *E. geniculata* Jones, 1971. Kenya.
9. *E. hirsuticauda* Menzies, 1962. Central southern Chile.
10. *E. latipes* [Barnard, 1914, as *Pontogeloides latipes*; includes *Excirolana carangis* (Van Name, 1920)]. West and South Africa.
11. *E. linguifrons* (Richardson, 1905). California.
12. *E. mayana* (Ives, 1891). Caribbean and tropical eastern Pacific.
13. *E. monodi* Carvacho, 1977. Chile.
14. *E. natalensis* (Vanhöffen, 1914). Southern Africa and Madagascar.
15. *E. orientalis* (Dana, 1853). Indo-West Pacific, from Madagas-

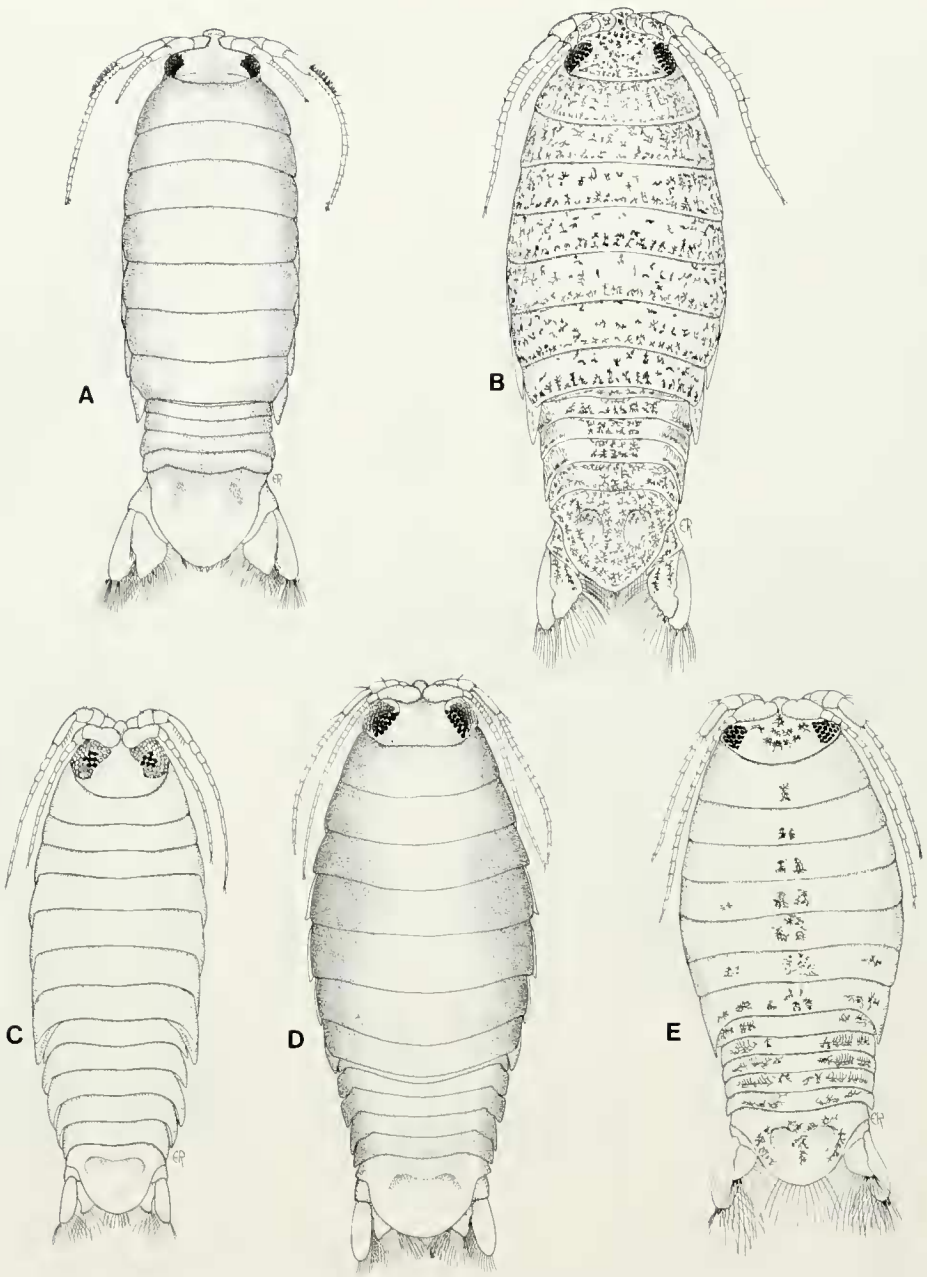

Figure 35. *Excirolana* of the tropical eastern Pacific, dorsal views: A, *E. mayana* (Mexico, Sonora, Puerto Peñasco, 17 June 1972), adult female. B, *E. mayana* (Pacific Panama, Farfan Beach, 11 Feb. 1985), juvenile female. C, *E. braziliensis* (USNM 43655), holotype, male (Brazil). D, *E. braziliensis* (AHF Cat. No. 2000-01), holotype morph (Mexico, Sinaloa, Mazatlan). E, *E. chamensis* (LACM Type No. 3013), holotype, male (Pacific Panama).

car to tropical Australia, Philippines, Japan, and India (includes *Cirolana bambayensis* Joshi and Bal, 1959).

Key to Tropical Eastern Pacific *Excirolana* Species

1. Antennular peduncle articles 1 and 2 not fused (3 free peduncular articles); antennae of adults brushlike (anterior margin of proximal flagellar articles highly setose); pleotelson's posterior border round or subacute, with two small, terminal (submedial) marginal spines; coxal plates with oblique groove .. *E. mayana*
— Antennular peduncle articles 1 and 2 fused; antennae not brushlike; pleotelson's posterior border round, without marginal spines; coxal plates smooth 2
2. Mandibular palp of 2 articles; endopod of pleopod 5 divided; with large stellate chromatophores; interocular distance much greater than one eye width; length to 5 mm ..... *E. chamensis*
— Mandibular palp of 3 articles; endopod of pleopod 5 not divided (but with shallow or deep lateral incision); stellate chromatophores lacking or minute; interocular distance usually equal to width of one eye; length to 9 mm ..... *E. braziliensis*

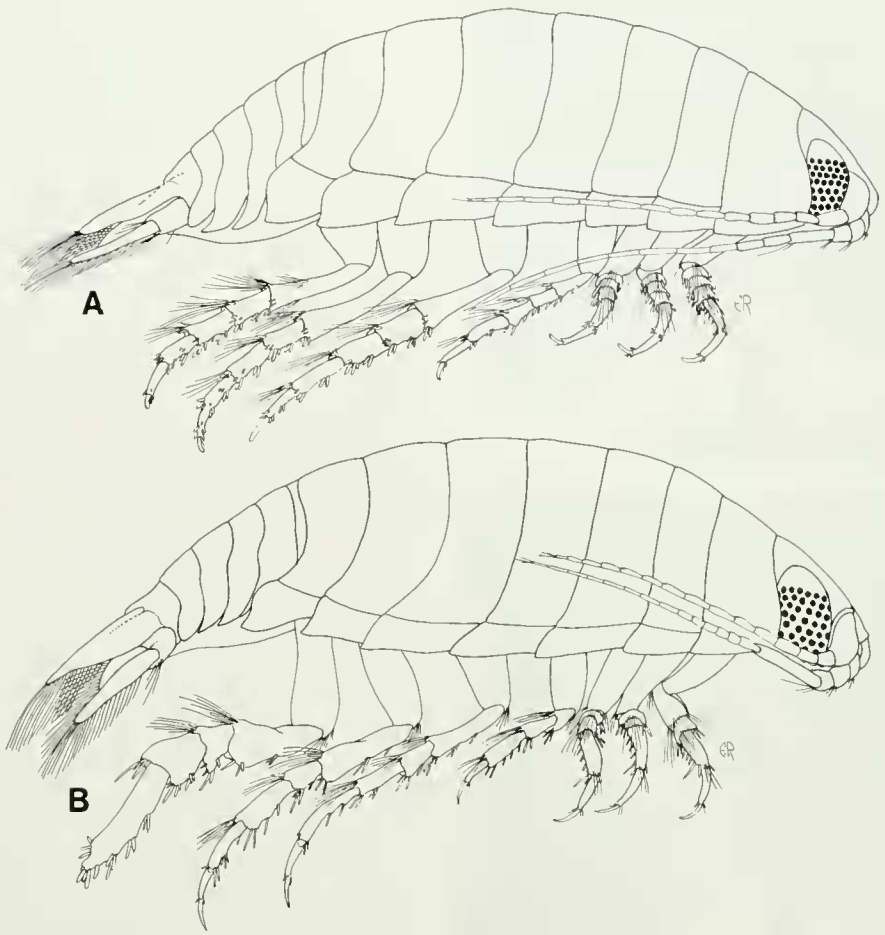

Figure 36. *Excirolana braziliensis*. Two syntypes of *Cirolana salvadorensis* Schuster, 1954 (from El Salvador): A, holotype morph. B, fossorial morph.

Excirolana braziliensis Richardson, 1912
Figs. 35C, D, 36–48

Excirolana braziliensis Richardson, 1912b: 203. Nierstrasz 1931: 149. Wade 1967: 512. Lemos de Castro and Silva Brum 1969: 7. Glynn, Dexter, and Bowman 1975: 509. Brusca 1980: 227. Carvacho and Haasmann 1984: 16. Brusca and Iverson 1985: 31. Zuñiga et al. 1985: 9. Weinberg and Starczak 1988: 296; 1989: 143. Kensley and Schotte 1989: 150. Schotte et al. 1991: 255.

Excirolana braziliensis (in part). Dexter 1976: 479; 1979: 543.

Cirolana kaepckei Bott, 1954: 107. Carvacho 1977: 30.

Cirolana mayana (in part). Dexter 1972: 449.

Cirolana salvadorensis Schuster, 1954: 105. Dexter 1974: 51.

Cirolana n. sp. González-Liboy, 1971 (unpublished master's thesis).

Type material examined.—(1) Male holotype (USNM 43655) of *Excirolana braziliensis*: Brazil, off Cape St. Roque, 12 m; R/V *Albatross* Sta. 2758; 16 Dec. 1887. (2) Paratypes (SMF 3606) of *Cirolana koepckei*: Peru, Strand de Barranca; 1952; "holotype morphs" (includes P-VII acute and blunt spine/dactyli forms; see below); 9 specimens. (3) Syntypes (SMF 3601) of *Cirolana salvadorensis*: El Salvador, Dept. La Paz, Los Blancos; 17 Oct. 1952; coll. O. Schuster; this portion of the syntype series contains "holotype morphs" (P-VII acute and blunt spine/dactyli forms), "fossorial morphs," and "transitionals" (8 adults, 4 juveniles); 12 specimens.

Other material examined.—(unless otherwise indicated lots are "holotype morphs" only—see below). Atlantic specimens: (4) Brazil, Rio de Janeiro, Copacobana Beach; USNM 86335; Nov. 1943; coll. Dr. Carlos Moreira; 1 specimen. (5) Panama, San Blas Islands; SDNHM; 19 Feb. 1980; coll. James G. Morin; 50+ specimens. (6) Panama, Shimmey Beach; USNM 227013; 1985; coll. James Weinberg; 8 specimens.

Gulf of California specimens: (7) Baja California, San Felipe; SDNHM; 26-30 Mar. 1951; coll. W. Evans and party (W-51-84); (includes both P-VII acute and blunt spine/dactyli forms); 10 specimens. (8) Baja California, San Felipe area (Campo Ensenada), ca. 31° N, 114°48' W, collected with hand net in 0–1 m, over sand bottom; (DFH 67-5 and 6), Acc. No. BI-67-2, CAS Cat. No. C-3924; 1967; coll. D. F. Hoese; (includes both P-VII acute and blunt spine/dactyli forms); 3 specimens. (9) Sonora, El Golfo de Santa Clara, taken from grunion during grunion run/spawn; AHF Cat. No. 2056-01; 15 Jan. 1975; coll. N. Moffat and D. A. Thomson; 1 specimen. (10) Sonora, Puerto Peñasco, night lighting; SDNHM; winter, late 1970s; coll. J. R. Hendrickson; 13 specimens. (11) Baja California, Angel de la Guarda Island, swarming at water's edge; AHF Cat. No. 2287-01; 1 Apr. 1972; coll. L. T. Findley; 18 specimens. (12) Baja California, San Francisco Island, night lighting, bottom sand with red and green algae, 16 m; SDNHM; 24 Feb. 1985; coll. Hank Chaney; 2 specimens removed from this lot for

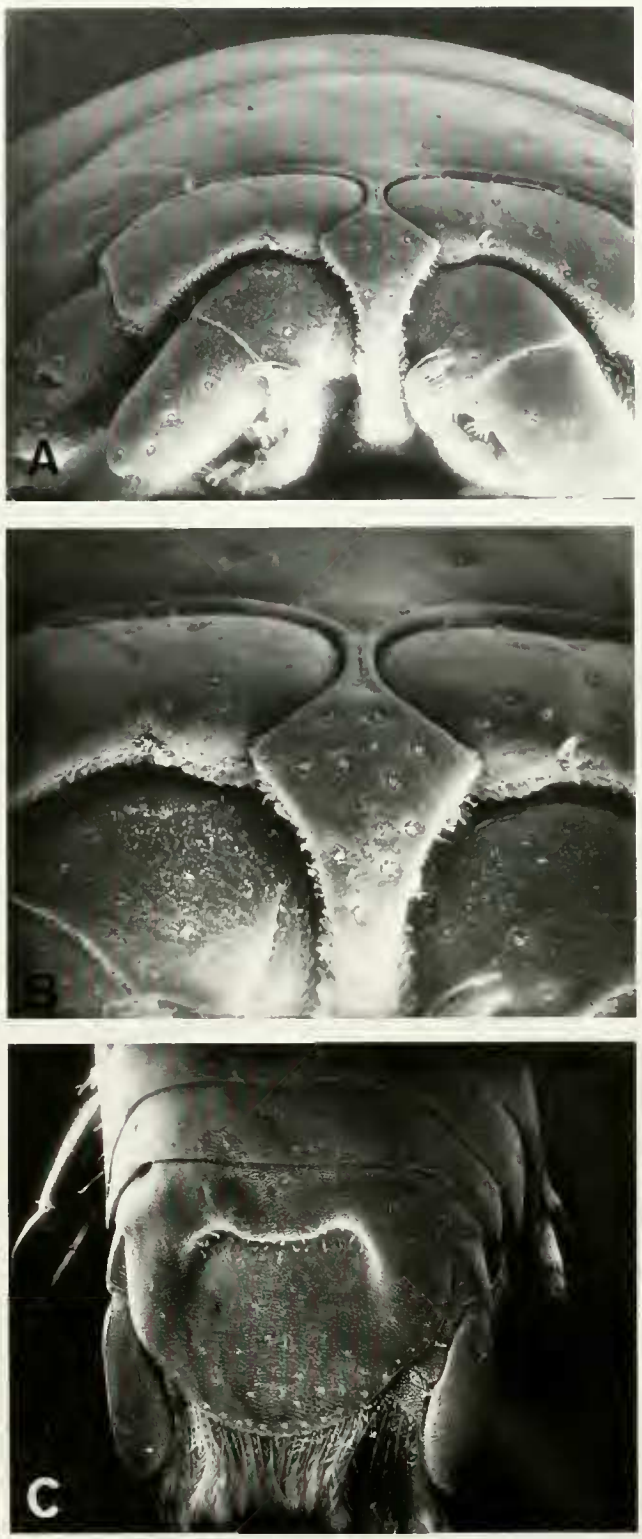

Figure 37. *Excirolana braziliensis* (from Mexico, Baja California Sur, Isla San Francisco; 24 Feb. 1985, coll. H. Chaney), scanning electron micrographs. A, B, frontal views showing fused rostrum and frontal lamina and cuticular sensillae in pits (A, 74×, B, 148×). C, pleotelson and uropods, 37×.

SEM by R. C. Brusca; 20+ specimens. (13) Baja California, Pulpito Point, 1 mi. offshore, night lighting, 2115–2215 hrs.; SDNHM; 22 June 1976; coll. R. H. Behrstock; 1 specimen. (14) Baja California, Palmas Bay, N. of Los Barriles, Hermosa Beach, in front of trailer park; EWI 81-7, SDNHM; 30 June 1981; coll. E. W. Iverson; 20+ specimens. (15) Sonora, 9 mi. S.E. El Tornillal (ca. 25 mi. S.E. El Golfo de Santa Clara), water temp. 21.2°C, air temp. 20.4°C; UA fish collection Cat. No. 69-80, SDNHM; 21 Mar. 1969; coll. K. Muench; 3 specimens. (16) Baja California, Chivato Point, in water over sand beach; SDNHM; 12 Aug. 1976; coll. R. Brusca, D. Perry; 3 specimens. (17) Sonora, Guaymas area, near San Carlos Bay, "in tidepools, with *Conus* sp."; SDNHM; 9 Apr. 1974; coll. M. Wicksten; 1 specimen. (18) Sonora, ca. 14 mi. E.S.E. of Guaymas, Estero Yasicuri, 27°51.5' N, 115°38.5' W; SDNHM A.0115; 13 Aug. 1988; coll. L. T. Findley; 1 female with oostegites. (19) Baja California, Evaristo Point, night light over soft bottom; LACM; 16 Mar. 1985; coll. H. Chaney; 50+. (20) Baja California, Agua Verde Bay, night light over sand and algae 9 m; LACM; 27 Feb. 1985; coll. H. Chaney; 25 specimens. (21) Baja California, Agua Verde Bay, night light over 15 m sand bottom; LACM; 15 Mar. 1985; coll. H. Chaney; 6 specimens. (22) Baja California, Los Frailes, sandy beach; USNM 150033; 27 Jan. 1972; coll. D. Dexter; 50+ specimens. (23) Baja California, Los Frailes, night light over 18 m; LACM; 17 Feb. 1985; coll. H. Chaney; 2 specimens. (24) Baja California, Cabo San Lucas; R/V *Albatross*, USNM 69565; 1911; 50+ specimens. (25) Baja California, Pichilinque Bay (near La Paz); night light; R/V *Albatross* Sta. No. A-5767, USNM 69710; 1911; (includes both P-VII acute and blunt spines/dactyli forms); 2 specimens. (26) Baja California, S.E. side Carmen Island, night lighting; R/V *Albatross* Sta. No. A—5767, USNM 69699; 1911; 200+ specimens. (27) Baja California, S.E. side Carmen Island; R/V *Albatross* Sta. No. A-5767, USNM 69700; 1911; 30+ specimens. (28) Sinaloa, Estero El Verde (near Mazatlan); AHF Cat. No. 2000-01; (P-VII blunt spine/dactyli form); 9 specimens.

Central Eastern Pacific specimens: (29) Costa Rica, Quepos, Cocal Beach, sand beach; USNM Acc. No. 309774, USNM 150034; 27 Feb. 1971; coll. D. Dexter; label in jar reads "*Cirolana salvadorensis* Schuster, 1954; found in *C. braziliensis* vial"; includes "holotype morphs" (both P-VII acute and blunt spine/dactyli forms), "fossorial morphs," and "transitionals"; 50+ specimens. (30) Panama, Naos Island, Boy Scout Beach and Lab Beach, sand beaches; USNM 227012; 1985; coll. James Weinberg; ca. 20 specimens. (31) Panama, Naos Island, Boy Scout Beach; SDNHM; Feb. 1986; coll. James Weinberg; 6 specimens. (32) Panama, Naos Island, Lab Beach, sand beach; SDNHM; Feb. 1986; coll. James Weinberg; 6 specimens. (33) Colombia, Depto. Valle de Cauca, Juanchaco Beach, sandy intertidal; SDNHM; 7 Mar. 1987; coll. G. A. Ramos; 2 specimens. (34) Ecuador, Puerto Mono, beach transect; SDNHM; 1 June 1975; coll. B. A. F. Hammond; 27 specimens. (35) Ecuador, Salinas, sand beach; USNM 155475; coll. B. A. F. Hammond; 20+ specimens. (36) Ecuador; USNM Acc. No. 327410; P-PT-II; accessioned 31 May 1975; includes "holotype morphs," "fossorial morphs," and "transitionals"; 10 specimens. (37) Chile, Concepción, Playa Celulosa, sand beach, intertidal; 27 Mar. 1979; coll. O. Aracena et al. ("Univ. Concepción Pollution Study Project"); 50+ specimens.

Description of male.—Cephalon somewhat immersed in pereonite 1. Eyes large but variable in size, mean interocular width usually about same as width of one eye, but variable from less than to slightly greater than width of one eye (Figs. 35C, D). Antennule and antenna lengths vary with age (at least in Pacific specimens); Glynn et al. (1975) noted, "antennule shorter (with 6–12 flagellar articles) than antenna (10–12 articles) up to a body length of 3–4 mm; between 3 and 4 mm body length the antennules are commonly subequal in size; in individuals exceeding 5 mm in length,

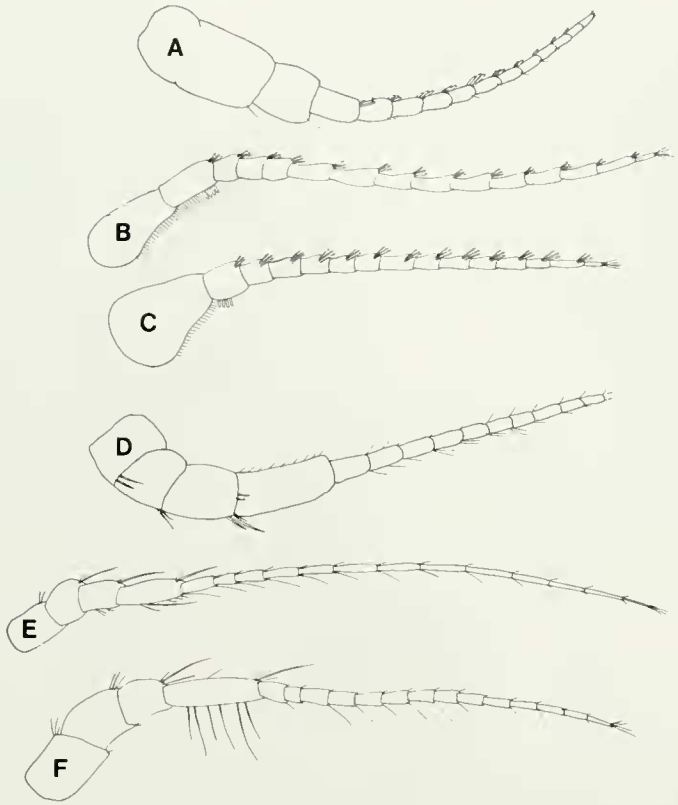

Figure 38. *Excirolana braziliensis*, A–C, antennules: A, holotype (USNM 43655), male. B, syntype of *Cirolana salvadorensis* (from same specimen as Fig. 42A; holotype morph). C, from *Cirolana salvadorensis* syntype (same specimen as Fig. 42B; fossorial morph). D–F, antennae: D, holotype (USNM 43655), male. E, syntype of *Cirolana salvadorensis* (same specimen as Fig. 42A; holotype morph). F, from *Cirolana salvadorensis* syntype (from same specimen as Fig. 42B; fossorial morph).

the antennule is longer (15–20 articles) than the antenna (11–16 articles); in some small individuals the antennules may vary from longer, shorter or equal to the antennae." Antennular peduncle articles 1 and 2 fused together; peduncle article 3 much wider than but subequal in length to first flagellar article; first flagellar article and all others except terminal article with distal aesthetascs (holotype is in poor condition and missing many setae) (Figs. 38A–C). Antennal peduncle 4-articulate, article 4 about twice length of 3; all antennal articles with simple setae, those of peduncular articles may be quite long (Figs. 38D–F). Mandible with innermost incisor cusp variable in size but always larger than others; spine row with 11–15 spines; molar process with 18–23 acute marginal spines and simple distal setae; palp 3-articulate, middle article longest, with setae on middle and distal articles (setae missing from holotype) (Fig. 39A). Maxillule's medial lobe with 3 large circumplumose spines and a small subapical stout circumplumose seta; lateral lobe with 11–13 stout barbed spines (Fig. 39B). Maxilla's medial lobe short, with plumose setae, simple setae, and short hairs; lateral lobe with simple and comb setae as figured (Fig. 39C). Maxillipedal endite with 5 or 6 plumose setae and one large coupling spine; palp 5-articulate, all articles with simple setae as figured (Fig. 39D).

Pereon and pleon margins evenly convex. Coxal plates usually visible dorsally on IV–VII, but visibility varies among specimens (Figs. 35C, D) Coxae smooth, without carinae or grooves. Pereopod I with stout acute spines and simple setae as figured; basis with up to 6 long thin simple setae on distal inferior margin; ischium with up to 4 simple setae on superior distal angle; merus expanded as distal superior lobe, with up to 5 long setae and with 4–9 spines on inferior margin; carpus short, subtriangular, with 2 or 3 spines on inferior margin; propodus with 3–6 spines on inferior margin and 2 long comb setae on distal margin (often broken off); dactylus elongate, nearly as long as propodus, and with comb setae at base of unguis (often broken off) (Fig. 40). Pereopod III with simple spines as figured; basis with up to 8 long simple setae on distal inferior margin; ischium with short and long spines on inferior margin and distal row of long submarginal setae on superior margin; merus expanded into a large scoop-shaped distal lobe on superior margin with stout spines and setae as figured; carpus with short and long spines on inferior margin as figured; dactylus subequal in length to propodus (Fig. 41). Pereopod VII with many spines and long simple setae as figured (Figs. 42–45); number and shape of spines and shape of articles highly variable (see below); basis with 1 or 2 spines and many long thin simple setae on distal inferior margin; ischium long, longer than merus or carpus, usually longer than propodus (except in certain cases, see below), and with 1 or 2 spine clusters on inferior margin and numerous spines on distal margin; merus and carpus with cluster of 1–3 spines on inferior margin and numerous spines on distal margin; propodus usually with one cluster of spines on inferior margin and long spines on distal margin (or greatly elongated and modified as described below); dactylus short;

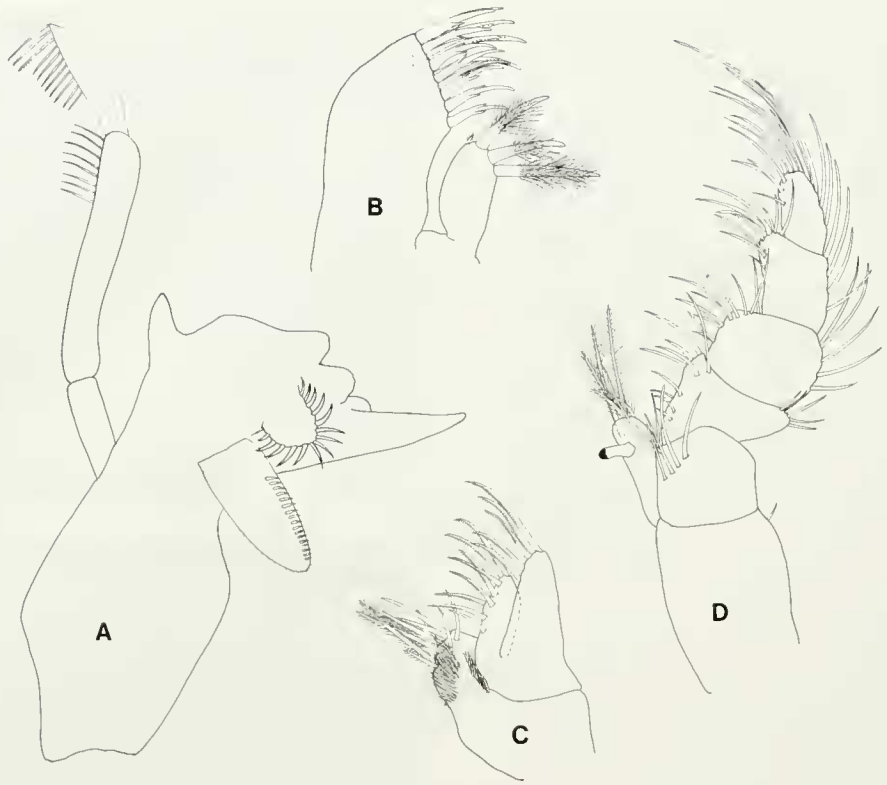

Figure 39. *Excirolana braziliensis* (AHF Cat. No. 2000-01), female, holotype morph. A, mandible (left). B, maxillule (left). C, maxilla (left). D, maxilliped (left).

unguis typically acute (but see below). Penes small, ovate, with serrate outer margins; set close together (Fig. 47I).

Pleon with 5 free pleonites, but first often partly covered by pereonite VII (Figs. 35C, D). All pleopods with lobe on lateral margin of peduncle, bearing a simple spine (often broken off); 3 coupling spines and several plumose setae on medial margin of pleopods 1–4 (plumose setae often broken off); exopod of pleopods 3–5 with short lateral incisions; endopod of 5 with ruffled lateral margin (Figs. 46, 47). Appendix masculina of male short and stout, articulated, arising about 0.25 distance up from base but not reaching tip of endopod (Figs. 46F, G, 47F, G). Uropodal exopod reaches or extends beyond posterior margin of pleotelson (Figs. 35C, D, 37C); endopod reaches or falls slightly short of posterior margin of pleotelson; endopod with 2 apical spines and a deep notch on lateral margin; exopod with 3 clublike apical spines; both rami (and peduncle) with PMS as figured (Fig. 48). Posterior border of pleotelson broadly rounded; dorsal depressions rounded and connected by transverse ridge (Figs. 35C, D).

Variations in leg morphology.—The exact numbers of spines and setae on the pereopods, and the shape of pereopod VII, are highly variable. In some cases this variability is clearly due to damage (setae and spines being broken off) or probably to simple genetic polymorphism (e. g., the number of spines in any given spine row or spine cluster). In the case of pereopod VII, however, the variations are dramatic, as noted below. The key (stable) features of pereopod I are the lobed merus, subtriangular carpus, long dactylus, apical comb setae on the propodus, and strong spination of the inferior margin in general; variations in spine numbers can be seen in the Fig. 40. The key (stable) features of pereopod III are the row of submarginal simple spines on the superior or distal margin of the ischium, the large apical lobe on the superior margin of the merus, and the long spines of the inferior margin of all articles (Fig. 41).

Pereopod VII is enormously variable. This variation was briefly noted by Glynn et al. (1975), who figured the two most extreme forms of these legs but did not discuss them. In the holotype (Fig. 45A) and the majority of material we have examined (e. g., Figs. 40, 41, 42A, B, 43A, B, 45A), the inferior margins of the ischium, merus, carpus, and propodus bear long acute spines, the dactylus is large and acute, and the propodus is about 1.5 times the length of the dactylus, with one medial spine cluster on the inferior margin. Most of the spines on pereopod VII bear a single sensory sensillum arising from an inner neural core. We refer to individuals with these types of seventh legs as "holotype morphs." In some specimens the spines and dactylar unguis appear to be eroded, rough, and blunt-tipped, and the spines may lose the sensory sensillae (e. g., Figs. 42C, D, 43G, H, 45B). In one premolt individual with blunt spines and blunt ungui the new cuticle can be seen beneath the old outer cuticle, and the blunt-tipped ungui were apparently to be replaced with typical acute-tipped ungui (Fig. 45C). This suggests that the bluntness of spines and dactyli on pereopod VII of some individuals may be due to simple mechanical erosion, perhaps as a result of digging in sand. The common occurrence of individuals with both the acute-spine/acute-dactyli and blunt-spine/blunt-dactyli morphologies in single samples (see Material Examined) further suggests an environmental–behavioral rather than a genetic explanation for this variation. This hypothesis could be tested in laboratory cultures.

Another different and dramatic variation seen in pereopod VII is a marked alteration in the shape of the articles themselves. In the holotype, all "holotype morphs," and most blunt spine/blunt dactyli specimens the leg articles are relatively narrow and symmetrical

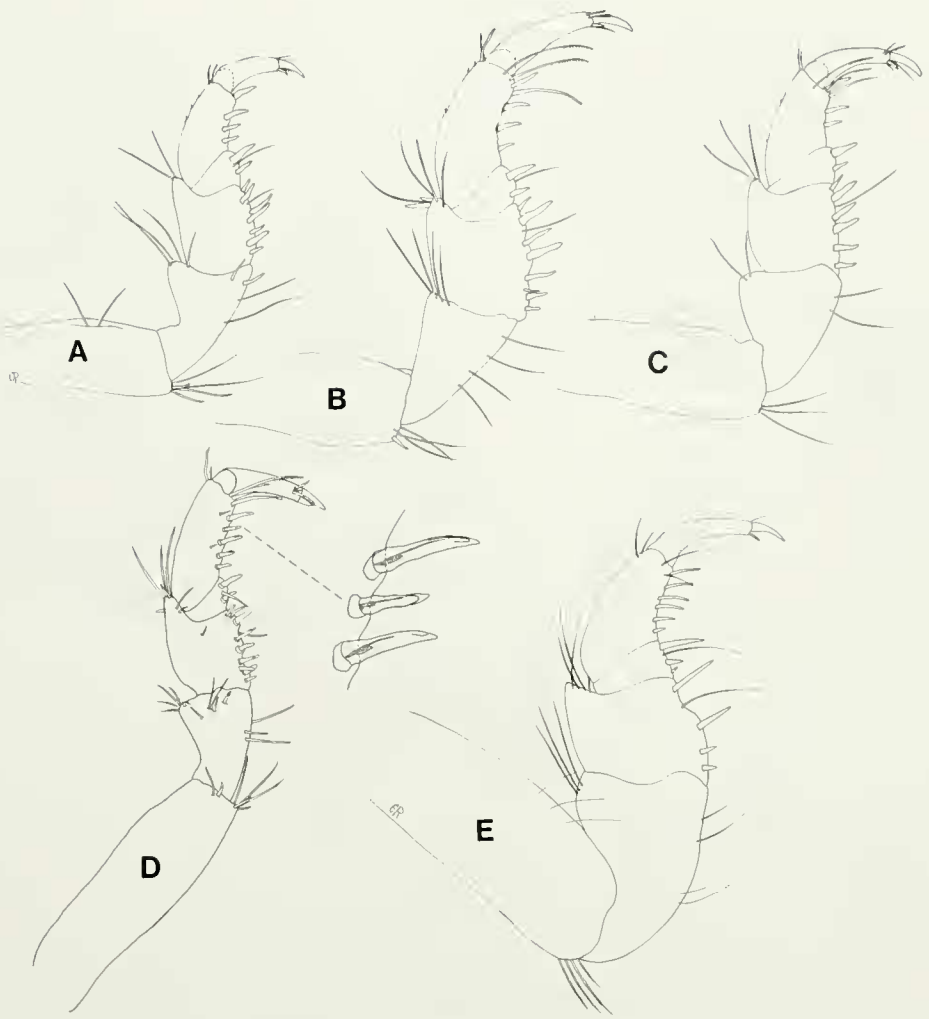

Figure 40. *Excirolana braziliensis*, pereopod I, posterior surfaces. A (Panama, Naos Island, "Lab Beach"), holotype morph (left). B (USNM Cat. No. 150034), fossorial morph (left). C (USNM Cat. No. 150034), holotype morph (left). D (AHF Cat. No. 2001-01) details of spines, female. E (USNM 43655), holotype (left).

(e.g., Fig. 36A). However, in some samples are individuals in which the seventh legs are greatly enlarged, the ischium, merus, and carpus become markedly broadened, expanded, and distally scoop-shaped, the propodus becomes enormously enlarged and elongated, reaching 10 times the length of the dactylus, and the dactylus is reduced and essentially vestigial. Figures 36B, 42C, D, and 45C illustrate these variations. For lack of a better term, we refer to these individuals as "fossorial morphs" (see Material Examined). Figures 43–45 show some intermediate stages in a "transition" from the "holotype" morphology of pereopod VII to a fully "fossorial" morphology. We refer to such intermediate individuals as "transitionals" (see Material Examined). In transitional individuals the dactylus varies from large and acute to somewhat reduced, the propodus is elongated (2–3 times the length of the dactylus) and bears 2 medial spine clusters along the inferior margin (rather than a single medial spine cluster, as in the holotype morph, or 3–5 spine clusters, as in the fossorial morph), and the merus and carpus vary from weakly expanded to slightly scoop-shaped. There are mixed morphs in many samples (see Material Examined), and some individuals even have one leg morphology on the left side and another on the right.

We are unable to discern any relationship to age, size, sex, or season in these variations of the seventh pereopod, nor do any other aspects of the animals' morphology appear to be correlated to these leg variations. Thus we suggest that the different leg morphologies may arise during the life history of a single individual, and that the variations reflect intraspecific polymorphism, rather than representing a group of closely related or sibling species. The occurrence of mixed morphs in single samples (e. g., the syntype series of *Cirolana salvadorensis*), the lack of relationship to size or sex, the presence of what appear to be transitional individuals, and some individuals with one leg type on the right and another on the left, all suggest to us that the modifications of the seventh pereopod may develop in response to ecological factors, rather than being genetically determined or fixed throughout the life of an individual. The seventh leg of the fossorial morph is strikingly similar to the digging legs of certain burrowing amphipods of the Haustorioidea, such as *Urohaustorius* Sheard and *Prantinus* Barnard and Drummond (Barnard and Karaman 1991). Because *Excirolana braziliensis* is also a burrower, it seems reasonable to hypothesize that the modificaitons of the seventh leg reflect a stage in the life history of this species specialized for intensive burrowing, hence our coining the term "fossorial morph."

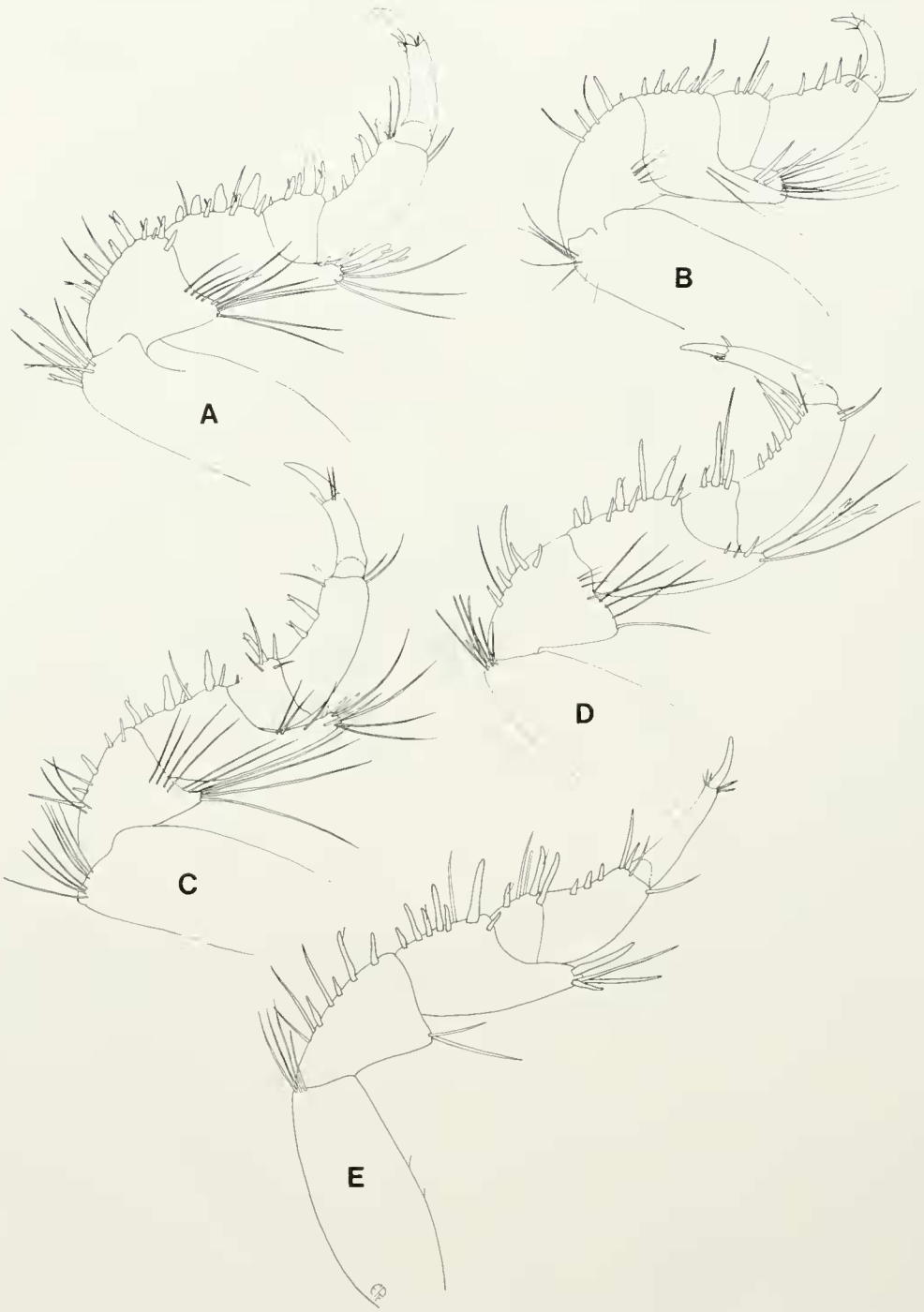

Figure 41. *Excirolana braziliensis*, pereopod III (right): A (Mexico, Baja California, San Felipe), holotype morph. B (USNM 43655), holotype, male. C (Pacific Costa Rica, Quepos, Playa Cocal), holotype morph. D (Mexico, Sinaloa, Mazatlan), holotype morph. E, syntype of *Cirolana salvadorensis* (female), fossorial morph (from same specimen as Fig. 42B).

Female.—Similar to male. Females of this species are capable of developing on pereopods II–IV small oostegites that are very thin and tightly pressed against the sternum.

Size.—To maximum length of 11 mm.

Distribution.—Atlantic coast: Gulf of Mexico and Caribbean to Uruguay. Pacific coast: Gulf of California to central Chile. Littoral to at least 16 m, probably somewhat deeper.

Remarks.—*Excirolana braziliensis* is a widespread amphi-American species. On the Pacific coast it is the most common species of the genus living in the sand just below the water line. Our attempts to resample this species at the type locality, at the now heavily trafficked beaches near Rio de Janeiro (December 1988),

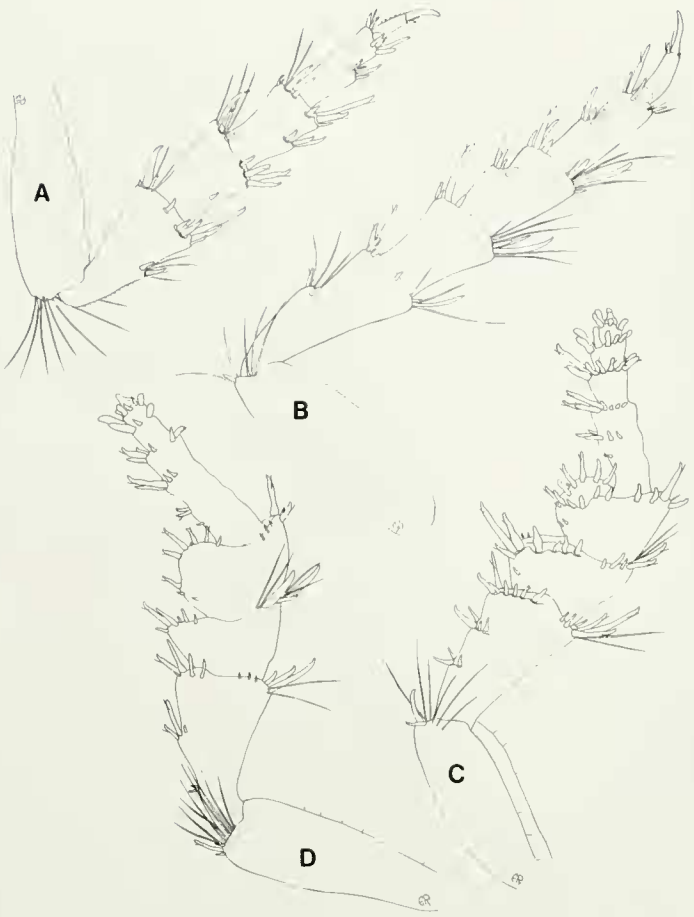

Figure 42. *Excirolana braziliensis*, extremes of morphological variation in pereopod VII. A, B (Pacific Panama, Naos Island, "Lab Beach"), anterior (A) and posterior (B) surfaces of left pereopod VII from holotype morph. C, D (Pacific Costa Rica, Quepos, Playa Cocal), anterior (C, right) and posterior (D, left) surfaces of pereopod VII from fossorial morph.

from Copacabana Beach south to Mangaratiba, met no success. Collections in Uruguay, between Montevideo and Punta del Este, also failed to recover *E. braziliensis*, although a different, undescribed *Excirolana* was found on a sand beach at Maldonado, just south of Punta del Este.

Weinberg and Starczak (1988, 1989) measured morphological variation in populations of *E. braziliensis* on both the Atlantic and Pacific coasts of Panama and South America. They found considerable morphological divergence along coastlines as well as between oceans, although this divergence was greatest between populations from opposite oceans. It is important to note that the ecological literature has consistently confused (or overlooked) the three eastern Pacific species of *Excirolana*, whose ranges overlap.

Excirolana chamensis Brusca and Weinberg, 1987
Figs. 35E, 49-51

Excirolana chamensis Brusca and Weinberg, 1987: 11.

Type material examined.—(1) Male holotype (LACM Type No. 3013): Panama, near Panama City, polluted beach near old part of town by National Theater; 15 Dec. 1984; coll. J. Weinberg; length 4.3 mm. (2) Male paratype (LACM Type No. 3014): same locality and collection as holotype; head broken from body. (3) Paratypes (LACM Type No. 3015): Panama, near Panama City, Chame Point Bay, fine sand beach; 25 Sept. 1984; coll. J. Weinberg; 5 adults (lengths 3.1–3.6 mm) and 2 mancas (lengths 1.6, 2.3 mm).

Other material examined.—(4) Panama, near Panama City, Chame Point; USNM 365595; coll. J. Weinberg; 1 specimen.

Description of male.—Dorsal surface ornately pigmented with stellate chromatophores distributed in band between eyes on cephalon, in median row on pereon, and in lateral rows on pleon (Fig. 35E). Eyes small, interocular distance greater than width of one eye. Antennules longer than antennae; antennular peduncle 2-articulate (due to fusion of articles 1 and 2); article 3 small, not much larger than first flagellar article (Fig. 50A). Antennal peduncle 4-articulate, articles 1–3 subequal, article 4 longest (Fig. 50B). Mandible with 2-articulate palp (Fig. 49D). Maxillule's lateral lobe blunt, with about 10 stout spines; medial lobe with 3 long slender circumplumose spines and 1 apical seta (Fig. 49A). Maxilla's lateral lobes with 3 and 6 comb setae, respectively; medial lobe with 8 simple and 3 plumose setae (Fig 49B). Maxilliped with single coupling spine (Fig. 49C).

Pereopods with acute spines along inner margin and acute dactyli (never with blunt or truncated spines or dactyli). Pereopod I: ischium with several stout spines (Fig. 50C). Pereopod VII: ischium without lateral spines (Fig. 50E). Coxal plates smooth, without carinae or grooves.

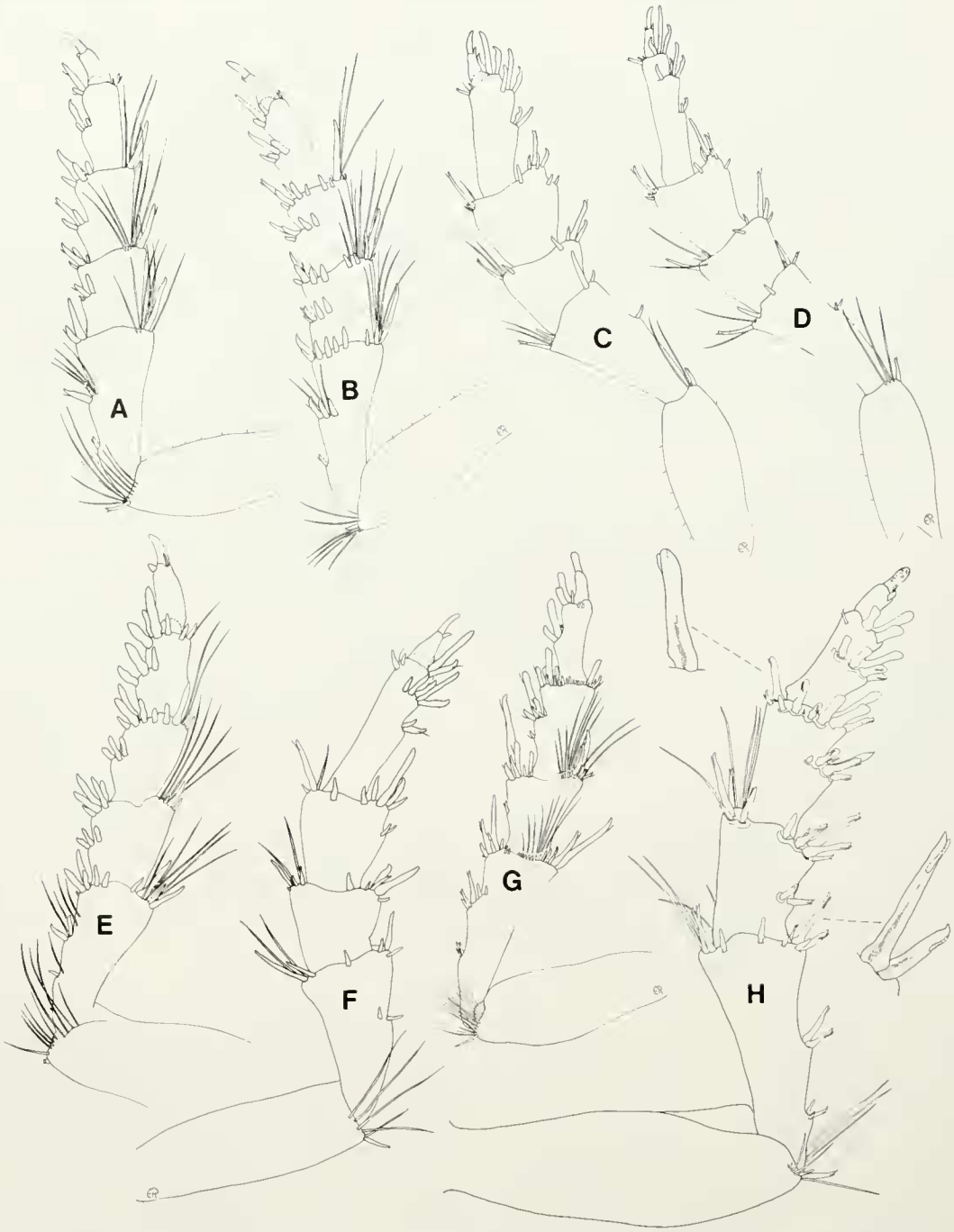

Figure 43. *Excirolana braziliensis*, morphological variation in pereopod VII. A, B (Mexico, Baja California, Punta Pulpito), posterior (A, left) and anterior (B, right) surfaces of pereopod VII. C, D (Pacific Costa Rica, Quepos, Playa Cocal), posterior (C, right) and anterior (D, left) surfaces of pereopod VII. E, F (Pacific Costa Rica), anterior surfaces of pereopod VII (E, right; F, left). G, H (Mexico, Sinaloa, Mazatlan), posterior (G) and anterior (H) surfaces of left pereopod VII.

Pleonite 1 not hidden by pereonite VII (Fig. 35E). Pleopod 5's endopod fully divided (Fig. 51E). Pleotelson's posterior border round, without marginal spines. Uropodal exopod nearly twice as long as endopod, with 6 long, thin, simple, apical spines, 2 large medial spines, and numerous very short medial spines; with plumose setae on medial margin and apex (Fig. 51F). Uropodal endopod extends barely to posterior margin of pleotelson; with 3 distomedial spines and PMS along distal inner and outer margins. Flat surfaces of both uropodal rami covered with very fine setae. Appendix masculina of males stout and short, arising off proximal lamellar lobe of endopod, one third distance up base and not reaching apex of endopod (Fig. 51B). (For expanded description see Brusca and Weinberg 1987.)

Female.—Similar to male.

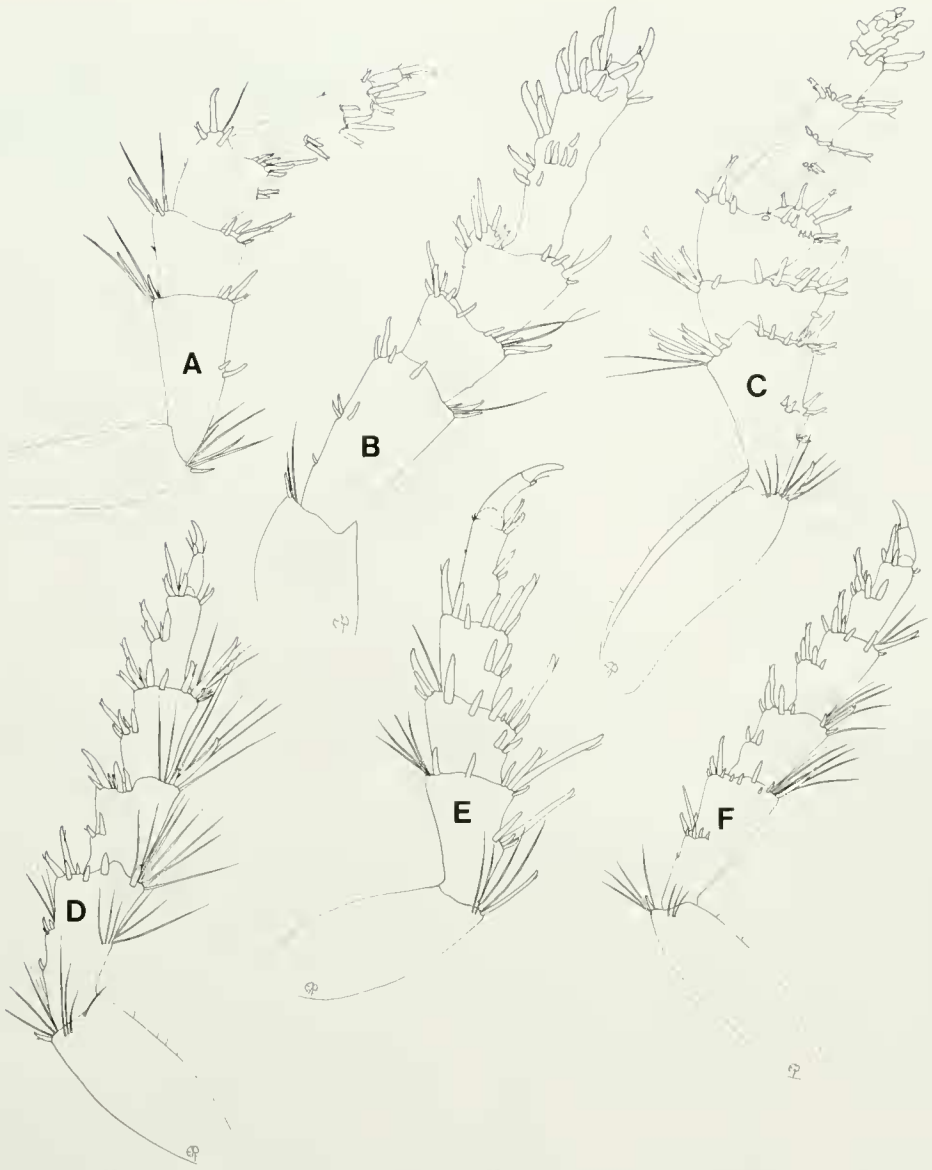

Figure 44. *Excirolana braziliensis*, morphological variation in pereopod VII. A–C (3 individuals from Pacific Costa Rica, Quepos, Playa Cocal, USNM 150034): A, anterior surface (left). B, posterior surface (left). C, anterior surface (left). D (Pacific Panama, Naos Island, "Boy Scout Beach"), anterior surface (right). E (AHF 2000-01), anterior surface (left). F (USNM 86335), anterior surface (right).

Size.—To maximum length of 4.3 mm.

Distribution.—We have seen specimens only from the littoral region of Chame Point Bay (Panama City) and the Pearl Islands, Panama. H. A. Garces (In Litt.) reports the species at "National Theater Beach" and "under the Bridge of the Americas," in Panama City.

Remarks.—*E. chamensis* superficially resembles *E. braziliensis* but can be quickly differentiated by its smaller eyes, distinct chromatophore pattern, 2-articulate mandibular palp, fully divided endopod on pleopod 5, and acute spines on all pereopods.

Excirolana mayana (Ives, 1891)
Figs. 35A, B, 52–58

Cirolana mayana Ives 1891: 186. Richardson 1901: 512; 1905: 87. Moore 1902: 166.

Excirolana mayana Richardson 1912: 201b. Nierstrasz 1931: 149. Lemos de Castro and Silva Brum 1969: 3. Schultz 1969: 174. Menzies and Kruczynski 1983: 48. Bruce 1986a: 221. Kensley and Schotte 1989: 153.

Non-*Excirolana mayana*: see Menzies and Glynn 1968: 39, Fig. 15. Dexter 1972: 449 (uncertain identification).

Type material.—None available (see below).

Material examined.—Gulf of California (Sonora) specimens: (1) Puerto Peñasco, Cholla Bay, shelly sand, high tide zone; SDNHM; 11 June 1971; coll. J. Kudenov; 1 specimen. (2) Puerto Peñasco, sand beach at high tide, in about 1 m; SDNHM; 16 June 1972; captured while biting swimmer (C. A. Brusca); coll. R. C. Brusca; 1 specimen. (3) Puerto Peñasco, sand beach in front of "Garcia House," 0–1 m (high tide); SDNHM; 17 June 1972; collected biting bodies of R. C. and C. A. Brusca; 11 specimens. (4) Puerto Peñasco, sand beach in front of "Garcia House," on dead fish; SDNHM; 17 June 1972; coll. R. C. Brusca; 30+ specimens. (5) Puerto Peñasco, night lighting, collected with *Excirolana braziliensis*; SDNHM; winter, late 1970s; coll. J. R. Hendrickson; 1

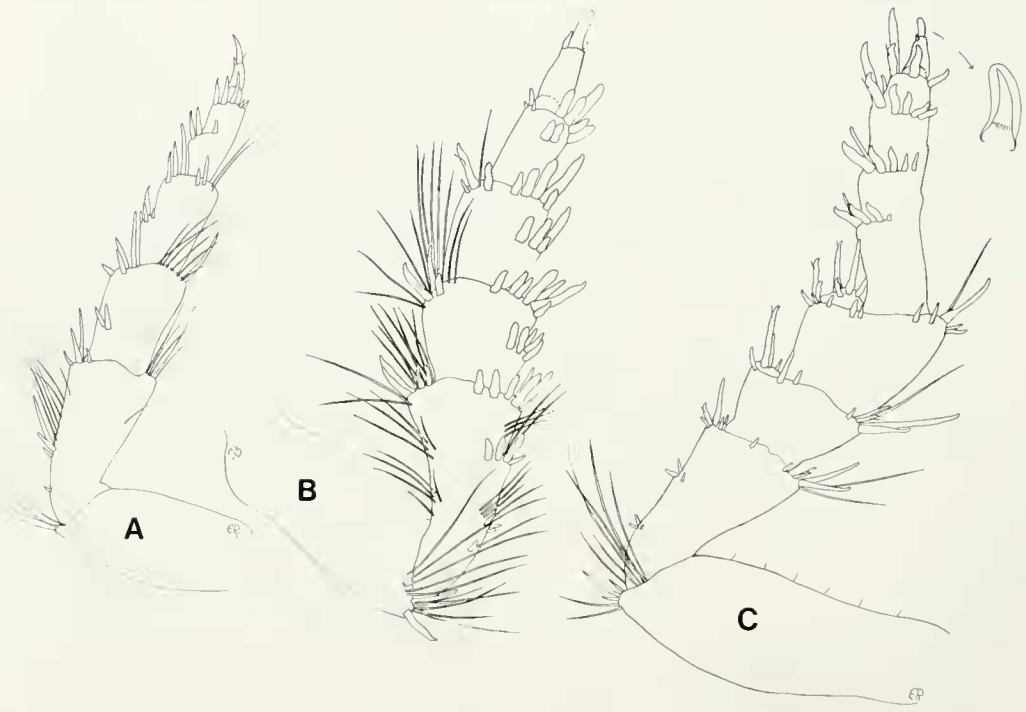

Figure 45. *Excirolana braziliensis*, morphological variation in pereopod VII. A, holotype (right). B, syntype of *Cirolana salvadorensis* (holotype morph). C, syntype of *Cirolana salvadorensis* (fossorial morph, female).

specimen. (6) Estero de los Seris (= Estero Vibora); SDNHM; 26 June 1975; coll. R. C. Brusca; 5 specimens. (7) New Kino, Connolank Bay, rocky shore; SDNHM; 22 June 1966; coll. D. A. Thompson; 1 specimen.

Gulf of California (Baja California [Norte]) specimens: (8) Sargento Point, intertidal; SIO Acc. No. BI60-18, Cat. No. C3531; 4 Apr. 1960; coll. A. Flechsig; 1 specimen. (9) 10–15 mi. N. of San Felipe, otter trawl; DGL 720531-2, SDNHM; 31 May 1972; coll. D. Lindquist; 1 specimen. (10) Campo Ensenada (N. of San Felipe), ca. 31° N, 114° 48' W, 0–1 m, hand net and sieve; CAS Acc. No. BI-67-2, Cat. No. C-3924; 22–23 May 1967; coll. D. F. Hoese; 4 specimens. (11) Campo Coloradito (ca. 38 mi. S. of San Felipe), attacked fish being cleaned in surf-line at high tide, also biting swimmers; SDNHM; 15 June 1982; coll. P. M. Delaney; 20+ specimens. (12) Campo Coloradito, rocks on loose sand and gravel, mid-intertidal; SDNHM A.0139.2; 17 June 1991; coll. R. C. Brusca; 3 specimens. (13) Los Angeles Bay, attracted to German sausages at water line, 0900 hrs.; SDNHM A.0034; 20 May 1988; coll. R. C. Brusca and R. Wetzer; 100+ specimens. (14) Estero La Ramada, 31° 17' N, 114° 53' W; SDNHM; 31 May 1972; coll. P. G. Lindquist; 1000+ specimens. (15) 20 mi. N. of San Luis Gonzaga Bay, pebble–cobble beach in front of ruins of El Almacen (across the channel from El Muerto Island), taken by hand while swimming in 0.5–1 m water; SDNHM; 23 Mar. 1972; coll. L. T. Findley; 6 specimens. (16) San Luis Gonzaga Bay, Okie's Landing, inside jellyfish stranded on beach; SDNHM; Mar. 1967; coll. E. Robinson; 4 specimens. (17) Los Angeles Bay, SE side of bay, coarse sand beach; EWI-9, LACM; 16 Aug. 1980; coll. E. W. Iverson; 10+ specimens. (18) Los Angeles Bay; SDNHM A.0034; 24 May 1988; coll. R. C. Brusca and R. Wetzer; 100+ specimens.

Gulf of California (Baja California Sur) specimens: (19) S. of Chivato Point, from cove just north of Santa Ines Point, beach screening in surf zone; SDNHM; 26 June 1981; coll. E. W. Iverson; 1 specimen. (20) Concepcion Bay, rinsed from algae washed ashore on beach; SDNHM; 6 Dec. 1971; coll. R. Brusca and J. L. Barnard; 22 specimens. (21) Concepcion Bay; EWI-12, LACM; 19 Aug. 1980; coll. E. W. Iverson; 20+ specimens. (22) Concepcion Bay, El Coyote Beach, in sand at wave-wash line; SDNHM; 9 Sept. 1985; coll. J. P. Donahue; 30+ specimens. (23) Espiritu Santo Island, "parasitic on fish," 16 m; CAS Acc. No. 0690; Sept. 1971; coll. A. J. Ferreira; 1 specimen. (24) Cerralvo Island, 24° 08.75' N, 109° 51.5' W, "Pro-noxfish" sample, 5 m; RRG 1-37, SIO 61-259, Cat. No. C-3905; 22 June 1961; 4 specimens.

Central eastern Pacific specimens: (25) Mexico, Baja California Sur, Sebastian Vizcaino Bay, Miller's Landing, 28° 38' N, 114° 04' 12" W, cobble reef; SDNHM; 12 Dec. 1945; 5 specimens. (26) Costa Rica, Gulf of Nicoya, Morales Point, from gut of 178-mm catfish (*Arius dowi*), 0430 hrs.; SDNHM; 30 Oct. 1987; coll. W. Swelistowski; 1 specimen. (27) Panama, small beach near Farfan Beach, near entrance to Panama Canal; SDNHM; 11 Feb. 1985; coll. J. Weinberg; 2 specimens. (28) Panama, Uva Island, pebble beach, caught with rotten bonito left on beach for 3 minutes; SDNHM; 9 Nov. 1973; coll. P. Glynn; 200+ specimens. (29) Colombia, Ensenada de Utria, Isla Playa Blanca, intertidal, in coralline sand; SDNHM; 28 July 1986; coll. G. E. Ramos; 4 specimens.

Caribbean specimens: (30) Belize, Carrie Bow Cay, lagoon trap; AC-CBC-3141, SDNHM; June 1978; coll. A. Cohen; 20+ specimens. (31) Tobago, W. of Pigeon Point, beach debris; USNM Cat. No. 151601; 4 Apr. 1959; 3 specimens.

Description of male.—Cephalon not immersed in pereonite I; eyes moderate in size, interocular distance greater than width of one eye (Figs. 35A, B). Antennules extend to pereonite I or II; peduncle 3-articulate, all articles with simple setae at outer distal corner; articles 1 and 2 with short acute spines on inner margin; 9–14 flagellar articles, most distal articles with aesthetases (Fig. 55A). Antennae extend to pereonite III or IV; peduncle 4-articulate, first article with acute spines on inner distal margin; flagellum with 16–21 articles, as many as 10 of which, in adults, may bear long,

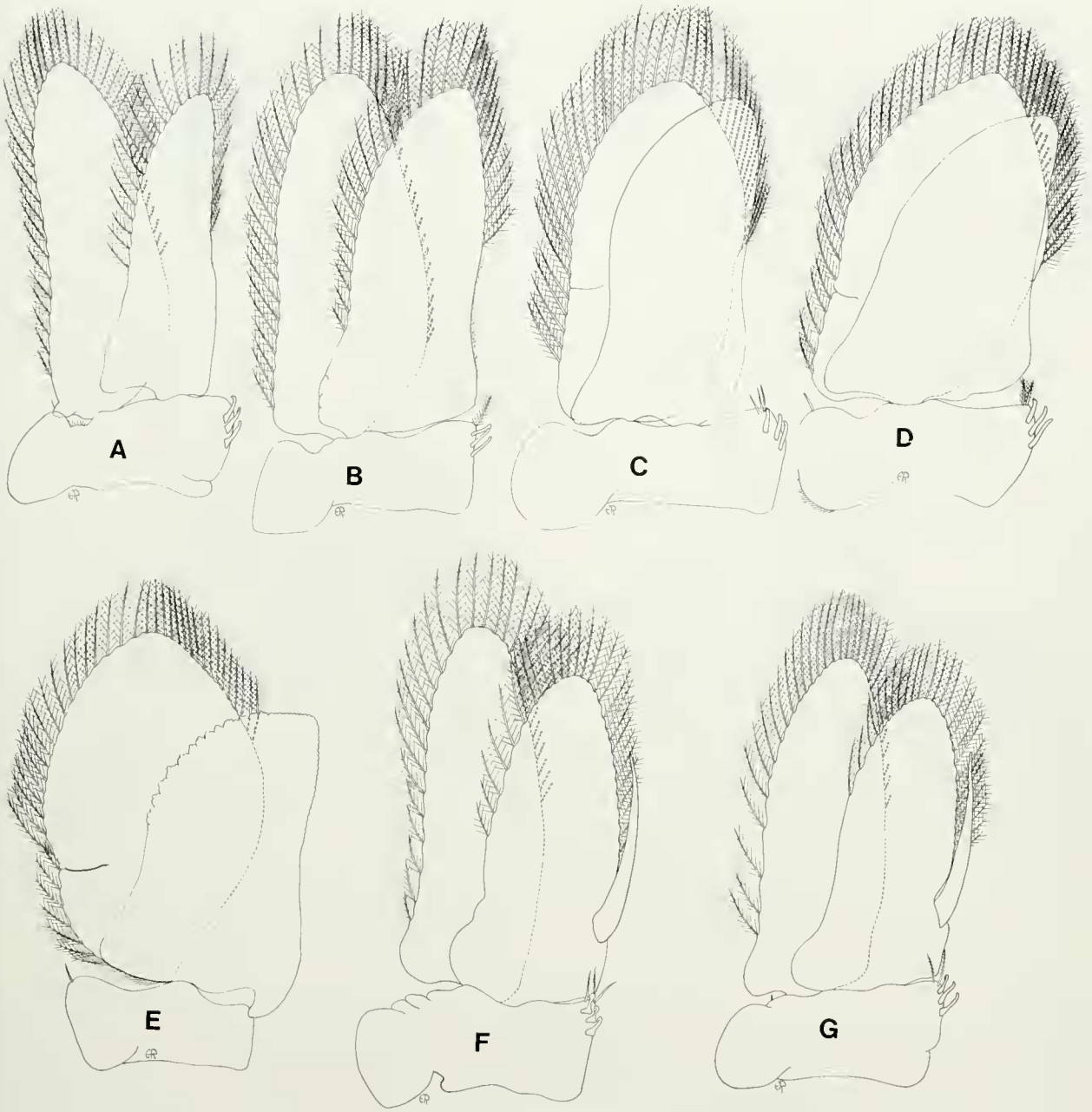

Figure 46. *Excirolana braziliensis*, A–E (USNM 86335), pleopods (right side) from a female collected at the type locality: A, pleopod 1. B, pleopod 2. C, pleopod 3. D, pleopod 4. E, pleopod 5. F, G (USNM 150034), second pleopods of two males: F, holotype morph (right side). G, fossorial morph (left side).

conspicuous, anteriorly directed setae (see Remarks) arising from two separate setal tracks on each article (Fig. 55B). Mandible with inner incisor cusp largest, outer cusp rounded; spines of spine row fleshy and blunt; palp 3-articulate, middle article much longer than proximal or distal articles; middle and distal articles highly setose as figured (Fig. 55C). Maxillule's outer lobe with about 11 stout, barbed spines, largest with visible row of denticles; inner lobe with 3 large circumplumose spines and 1 small seta (Fig. 55E). Maxilla's inner lobe with proximal plumose setae and stout simple distal setae; outer lobe with simple and comb setae as figured (Fig. 55D). Maxillipedal endite short, with 1 or 2 coupling spines and numerous distal plumose setae; palp 5-articulate, with long simple setae on articles 2–5 (Figs. 54D, 55F).

Pereon and pleon margin evenly convex. Coxal plates visible dorsally on III–VII or IV–VII (Figs. 35A, B); coxae with oblique grooves running from middorsal point to top of posterior angle. Pereopod I with molariform spines on inferior margin of ischium and merus as figured (Figs. 56A, 57D). Pereopod III with molariform spines on merus only (Fig. 56B). Pereopod VII without molariform spines but with numerous acute spines and simple setae (Fig. 56C). Penes large, fleshy, lanceolate, set close together.

Pleon with 5 free pleonites, the first largely overlapped by pereonite VII (Figs. 35A, B). All pleopods with lobe on lateral margin of peduncle, bearing a simple spine at the base (Fig. 58);

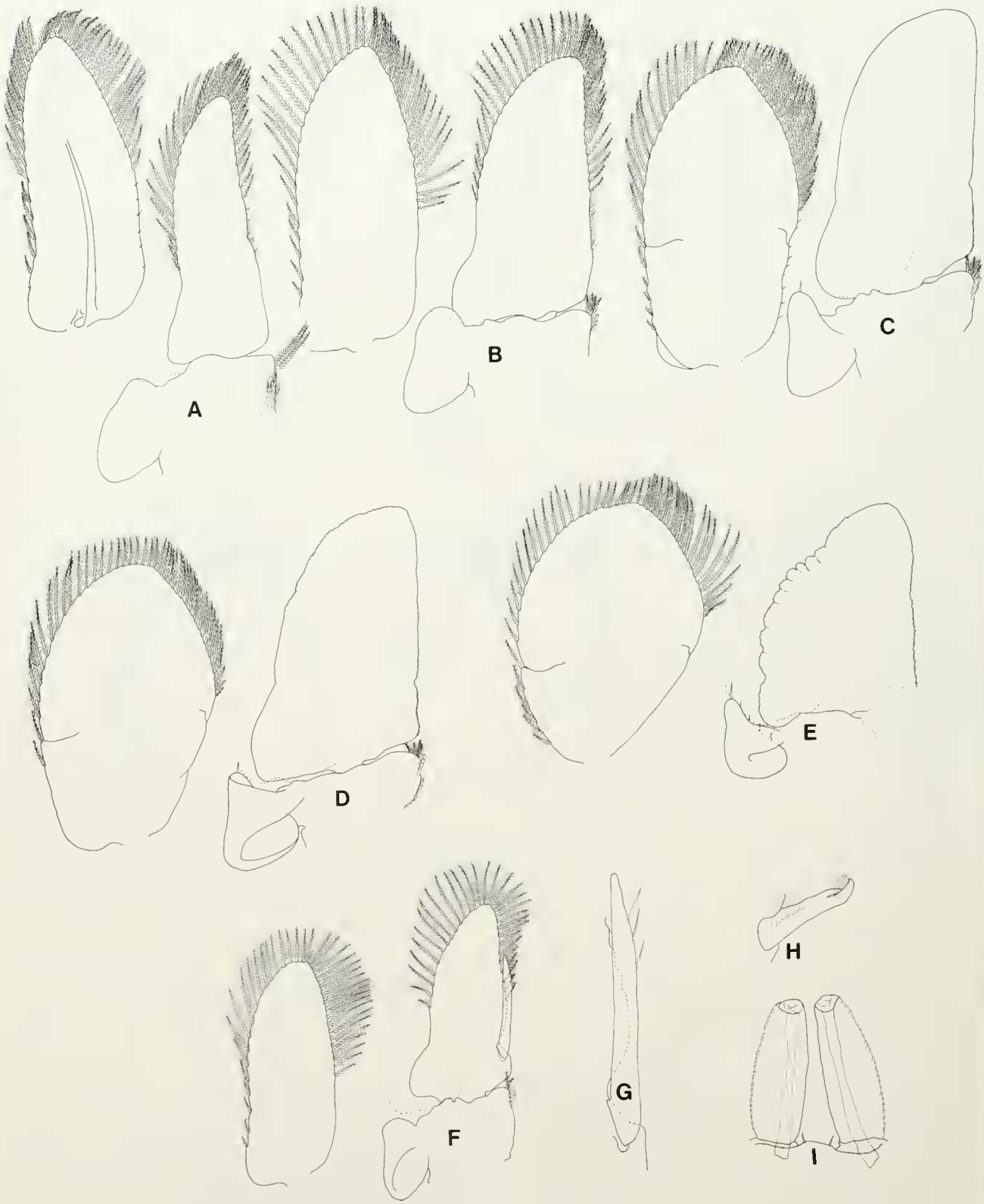

Figure 47. *Excirolana braziliensis* (AHF 2000-01), pleopods from a female (A–E) and a male (F, G); endopod and exopod separated, endopod on right. A, pleopod 1 (right). B, pleopod 2 (right). C, pleopod 3 (right). D, pleopod 4 (right). E, pleopod 5 (right). F, pleopod 2 (right). G, appendix masculina of pleopod 2 (right). H, coupling spine from pleopod 3, female, right. I, penes from male.

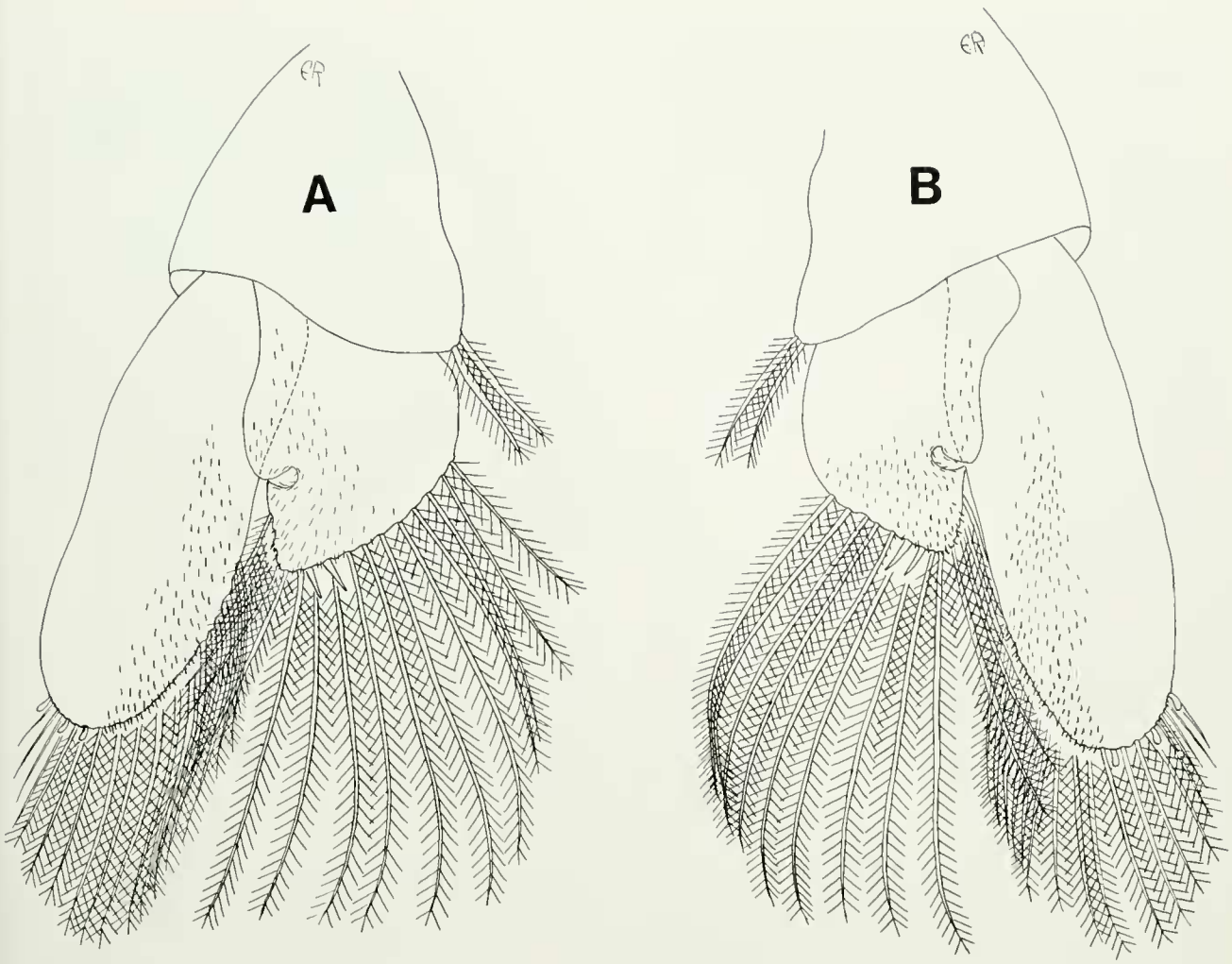

Figure 48. *Excirolana braziliensis* (AHF 2000-01) uropods from a male: A, left; B, right.

pleopods 1–4 with 3 or 4 coupling spines and plumose setae on medial margin of peduncle; pleopods 1 and 2 with PMS on both rami as figured; exopods of pleopods 4 and 5 with lateral incisions. Appendix masculina large and scythe-shaped, articulating subbasally, about 0.2 distance from base, not quite reaching tip of endopod (Fig. 58F). Pleotelson lateral margins somewhat convex, posterior margin rounded, with PMS set in notches and with 2 very small submedian apical spines (Figs. 35A, B, 57A). Both uropodal rami extend beyond margin of pleotelson; peduncle with 1 large spine on outer margin and 2 large and 2 small spines at outer distal angle; inner margin with PMS as figured. Uropodal exopod with 3 medial, 1 apical, and 1 lateral (subapical) spines and PMS as figured. Uropodal endopod with 5 medial, 1 apical, and one lateral (subapical) spines and PMS as figured (Fig. 56D).

Female.—Similar to male. Brooding females may have arising from coxae III, IV, and V well-developed oostegites that overlap in midline; oostegites are very thin and lie tightly pressed against the sternum, making them difficult to see.

Size.—To maximum length of 15 mm.

Distribution.—Florida to Venezuela (Atlantic) and northern Gulf of California to Colombia (Pacific). *E. mayana* is a littoral and shallow-water (to 16 m) subtidal species occurring in the same general area as *E. braziliensis*.

Remarks.—Despite its distinctive appearance, *Excirolana mayana* has been an enigmatic and often overlooked species. In his original description, Ives (1891) noted that the most distinctive feature of this animal is its brushlike antennae. Moore (1902) and Richardson (1901, 1905) also relied on the dense antennal setae to distinguish this species in their keys to *Cirolana*. We have found this "antennal brush" to be absent in juveniles and only weakly developed in young adults, a feature also noted in the original description. In the material we examined, the smallest female with a fully developed "antennal brush" was 7.8 mm long, the smallest male 5.7 mm. *E. mayana* also varies considerably in the expansion and contraction of dorsal chromatophores.

No adequate figures of *E. mayana* have been previously published. Richardson (1905), in copying the drawings of Ives (1891) and Moore (1902), appears to have accidentally copied figures of the penes of *Cymodocea caudata*, labeling the drawing as *Cirolana mayana*. Ives' (1891) drawings of this species are crude, especially his depiction of spines and setae. His drawing of the pleotelson shows a crenulate margin with 20–22 minute spines set in the notches and long setae arising between these spines. His description states that the pleotelson is "minutely crenulate on its posterior border, with very short spines inserted in the notches." Ives' drawings were from a small specimen (9 mm), and the lack of detail

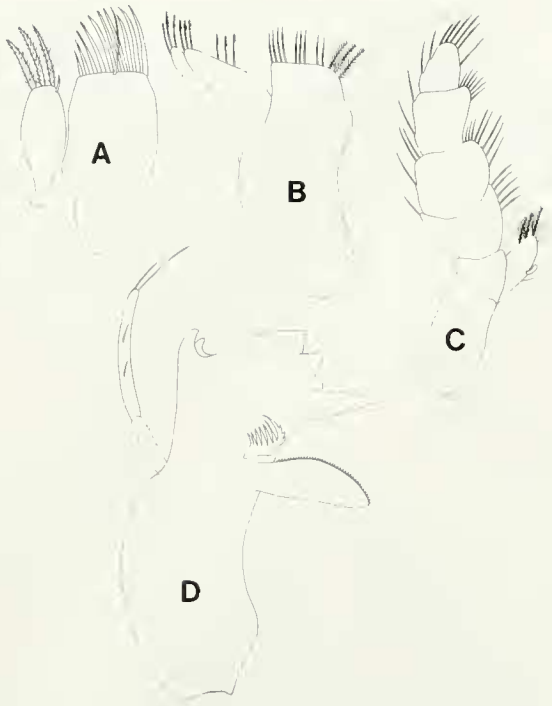

Figure 49. *Excirolana chamensis* (LACM Type No. 3014), paratype, male: A, maxillule (right). B, maxilla (right). C, maxilliped (right). D, mandible (left).

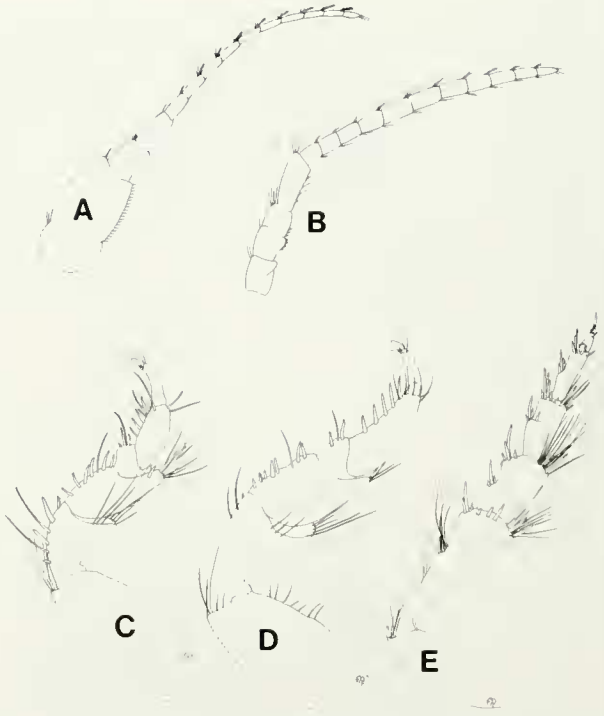

Figure 50. *Excirolana chamensis* (LACM Type No. 3014), paratype, male: A, antennule. B, antenna. C, pereopod I. D, pereopod III. E, pereopod VII.

raises suspicion about the accuracy of his illustrations and description. In the material we have examined, from both the eastern Pacific and Caribbean, the pleotelsonic notches house long setae and the only spines are a single minute pair at the apex. The specimens identified as *E. mayana* by Kensley and Schotte (1989) agree with our observations. The two apical spines on the pleotelson are so small that it is very likely Ives overlooked them (neither are they figured or mentioned by Kensley and Schotte 1989). Unless Ives' type material can be located, we cannot be positive his animals and ours are the same. However, we are reasonably confident they are, and we suspect that Ives simply misinterpreted the pleotelsonic margin. Ives also stated, "Spines and bristles upon the legs are not numerous," yet he illustrated the legs as being highly spinose—which they are.

Menzies and Glynn (1968) listed this species from Puerto Rico but overlooked Richardson's (1912a) genus *Excirolana*, citing it as *Cirolana mayana*. However, judged by their description and figures, Menzies and Glynn clearly misidentified their specimens (their material was probably a species of *Cirolana*). Menzies and Glynn also claimed that *E. mayana* is "probably a pantropical cosmopolite" but provided no data in support of this statement. Bruce (1986a) listed it as a possible Indo-West Pacific species but gave no records. Menzies and Kruczynski (1983) included this species in their key to Caribbean Flabellifera (incorrectly stating that the pleotelson lacks the submedian depressions characteristic of the genus) but did not describe or figure it. Dexter (1972) listed *Cirolana mayana* as the most abundant organism on both Pacific and Atlantic sand beaches in Panama. However, she later claimed (Glynn et al. 1975) that her material had actually been *E. braziliensis*, not *E. mayana*.

Remarkably, Richardson (1905) appears to have been the only person to have previously reported this common species from the Pacific. She noted in passing that she had been unable to distinguish some "dried specimens from San Francisco Bay, Lower California [presumably Bahía San Francisquito, Baja California], sent by Dr. Ritter" from Caribbean specimens of *E. mayana*. *Excirolana mayana* is one of the most abundant animals in the quiet bays of the Gulf of California, where it often occurs in vast numbers on sandy beaches. We have collected hundreds of specimens in a few minutes, simply by placing a dead fish or piece of meat at the water line, whereupon the isopods soon swarm out of the water or sand to begin consuming the bait. This is the largest *Excirolana* known from the tropical eastern Pacific.

Ives (1891) based his description on three specimens taken in 1890 at "Port of Silam," Yucatan Peninsula, by the "Expedition in charge of Professor Angelo Heilprin, sent by the Academy of Natural Sciences of Philadelphia to investigate the natural history of Yucatan and Mexico." Ives was a member of the expedition, but he gave no indication where the type material was deposited and we have been unable to locate it (it has not been found at the Academy of Natural Sciences of Philadelphia, the USNM, or the BMNH).

Metacirolana Kussakin, 1979

Type species.—*Cirolana japonica* Hansen, 1890, by subsequent designation (Kussakin 1979: 212). Holotype at ZMUC.

Synonymy.—Emended and subsequent to Bruce (1986a:31).

Metacirolana. Kensley 1984a: 33. Brusca and Iverson 1985: 36. Kensley and Schotte 1989: 153.

Description.—Body 2.0–3.0 times longer than broad; posterior pereonites and pleon sometimes with dorsal tubercles or carinae. Eyes usually well developed, moderate in size; absent in some species. Cephalon short with small to moderate rostral process. Frontal lamina anteriorly broad and dilated, freely projecting, often overlapping bases of antennules, often visible in dorsal aspect,

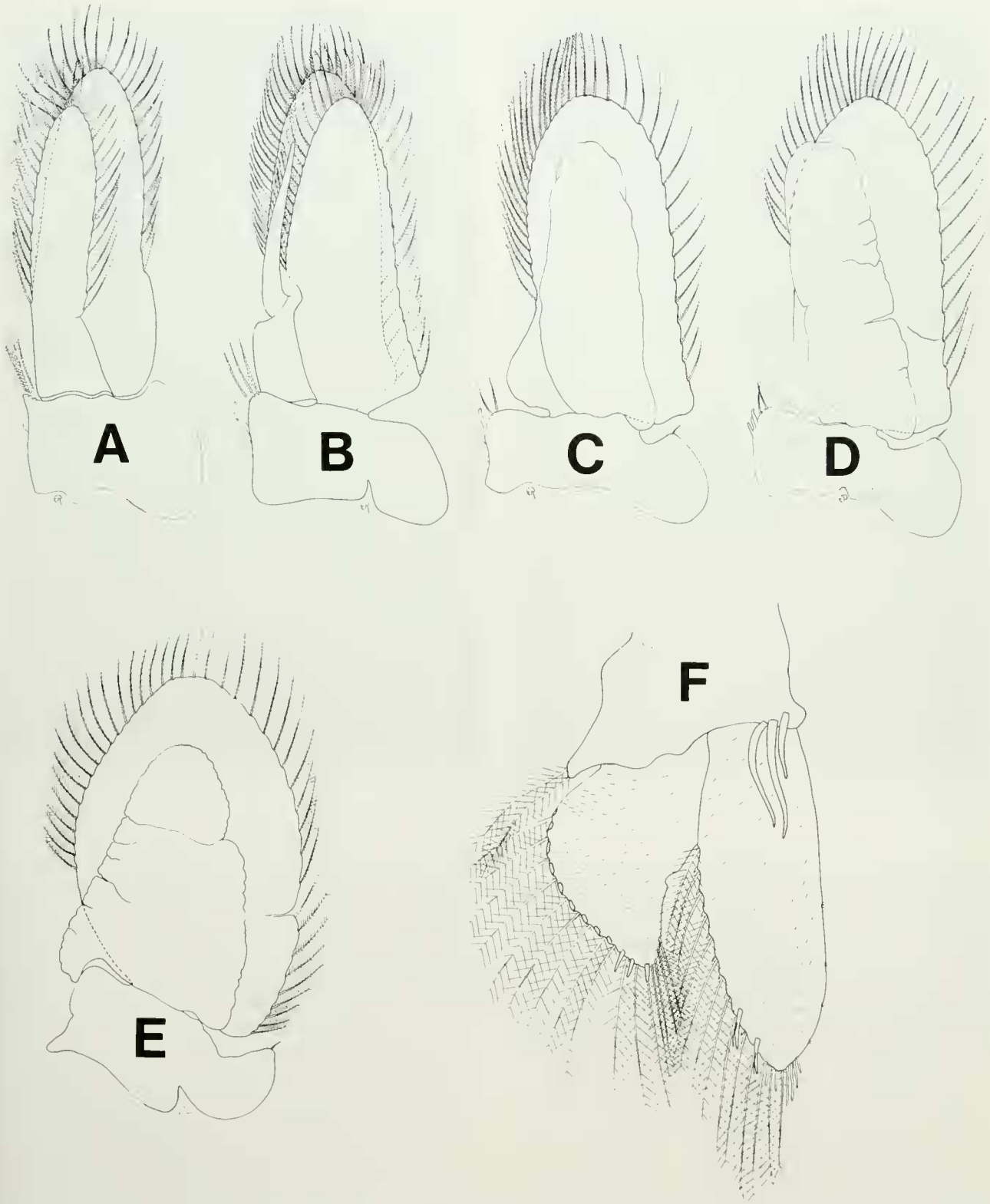

Figure 51. *Excirolana chamensis* (LACM Type No. 3014), paratype, male: A, pleopod 1 (left). B, pleopod 2 (left). C, pleopod 3 (left). D, pleopod 4 (left). E, pleopod 5 (left). F, uropod (left).

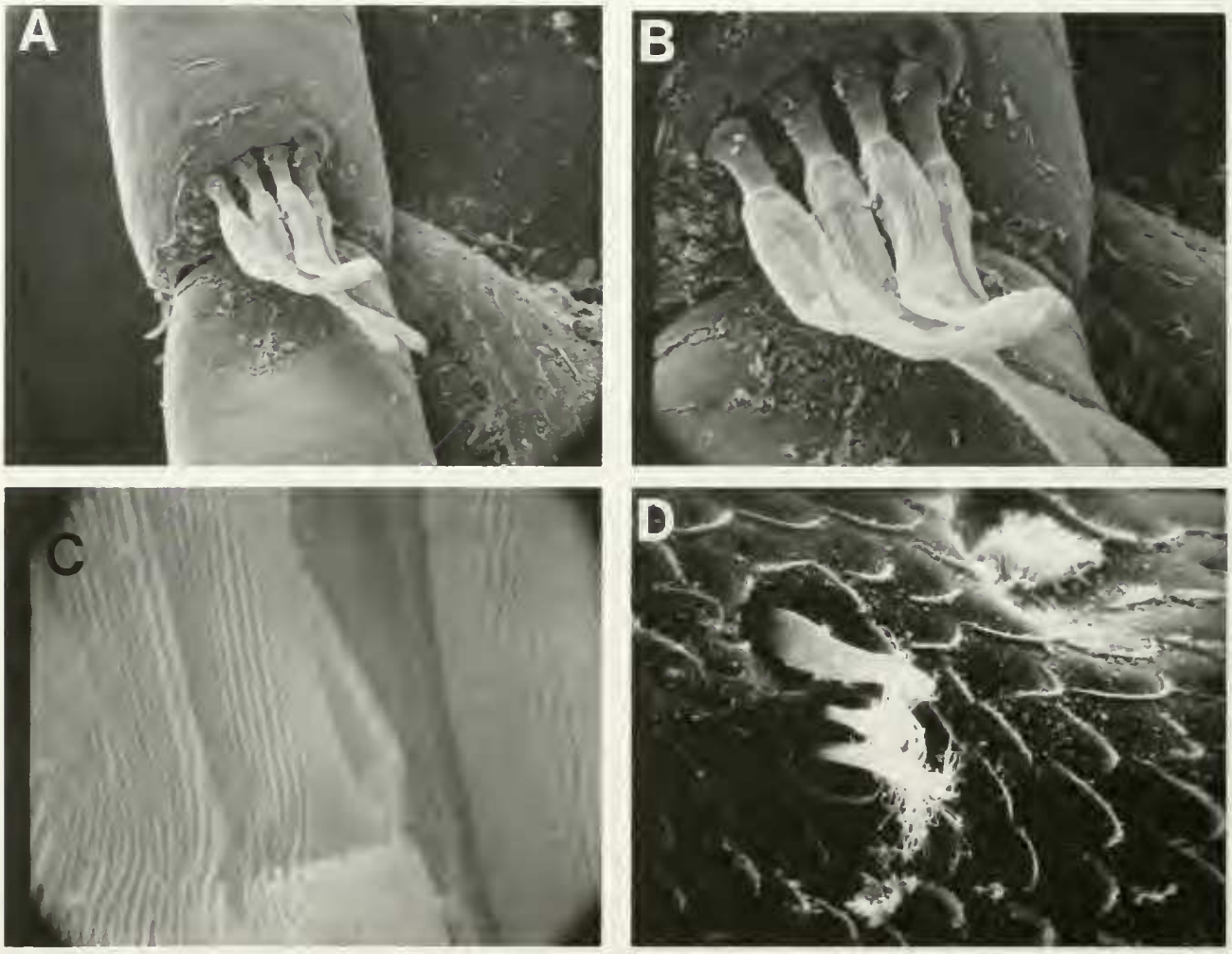

Figure 52. *Excirolana mayana*, scanning electron micrographs: A, antennule aethetascs, 740×. B, antennule aethetascs, 1480×. C, aethestasc surface, 14,800×. D, three setal types on antennal peduncle, 1332×.

posteriorly narrowed; clypeus wider than long, with ventrally projecting median triangular blade: labrum about as wide (or slightly narrower) but longer than clypeus. Antennule short, never extending beyond pereonite 1; peduncle 3-articulate; article 2 not articulating at right angle to article 1; peduncular article 2 or 3 longest; flagellum reduced, basal articles longer than broad. Antennal peduncle 5-articulate; article 5 longest, proximal two articles may be partially fused. Mandible with broad tridentate incisor and an additional small accessory tooth on medial (inner) margin of right mandible; middle lobe of left mandible usually low and bladelike; palp 3-articulate, extending beyond incisor; spine row a well-developed rounded lobe with long stout spines. Maxillule's medial lobe with 3 or 4 circumplumose spines, sometimes with reduced setulation, also occasionally with 1 or 2 short simple spines; lateral lobe with large stout spines, often barbed. Maxilla's medial lobe somewhat reduced (but more developed than in *Cirolana* and *Anopsilana*) and truncate, with bifurcate lateral lobe often reduced. Maxilliped slender; palp 5-articulate; palp article 3 much wider and longer than article 4; endite with 1 or 2 coupling spines and plumose setae.

Pereonite 1 usually short (subequal in length to pereonite II). All pereopods ambulatory, less spinose and setose than those of most other genera of the Cirolanidae. Pereopods I–III short; distal superior angle of ischium and merus not produced; carpus short, often triangular. Pereopods IV–VII slender, longer than pereopods I–III, with articles not markedly flattened. Penes flattened lobes, small to moderate in size.

Pleon with 5 free pleonites; lateral margins of pleonite 5 not overlapped or barely overlapped by pleonite 4. Pleopods 1 and 2 similar; peduncles subrectangular and broader than long, without lateral accessory lobes; appendix masculina inserted (about one-third distance from base) on endopod of male's pleopod 2. Exopods of posterior pleopods completely or nearly divided by medial transverse incision. Pleopod 5's endopod without PMS, with or without lobe on proximomedial angle, and without plumose setae or coupling spines on peduncle. Pleotelson and uropods with or without marginal spines. Pleotelson apex rounded, truncate or subtriangular, never indented. Uropodal peduncle inner angle acutely produced.

Remarks.—Metacirolana contains 28 species. The genus was resurrected by Bruce (1981a) to house a group of reasonably distinctive cirolanid species, including *Metacirolana joannae* (Schultz, 1966) of California waters and *M. sphaeromiformis* (Hansen, 1890), a species reported from the Caribbean (Menzies and Glynn 1968) and the Indian Ocean and western Pacific (Nordenstam 1946). Menzies and Glynn (1968) and Bruce (1981a) suggested that the latter species is circumtropical, but we have not found it in the eastern Pacific.

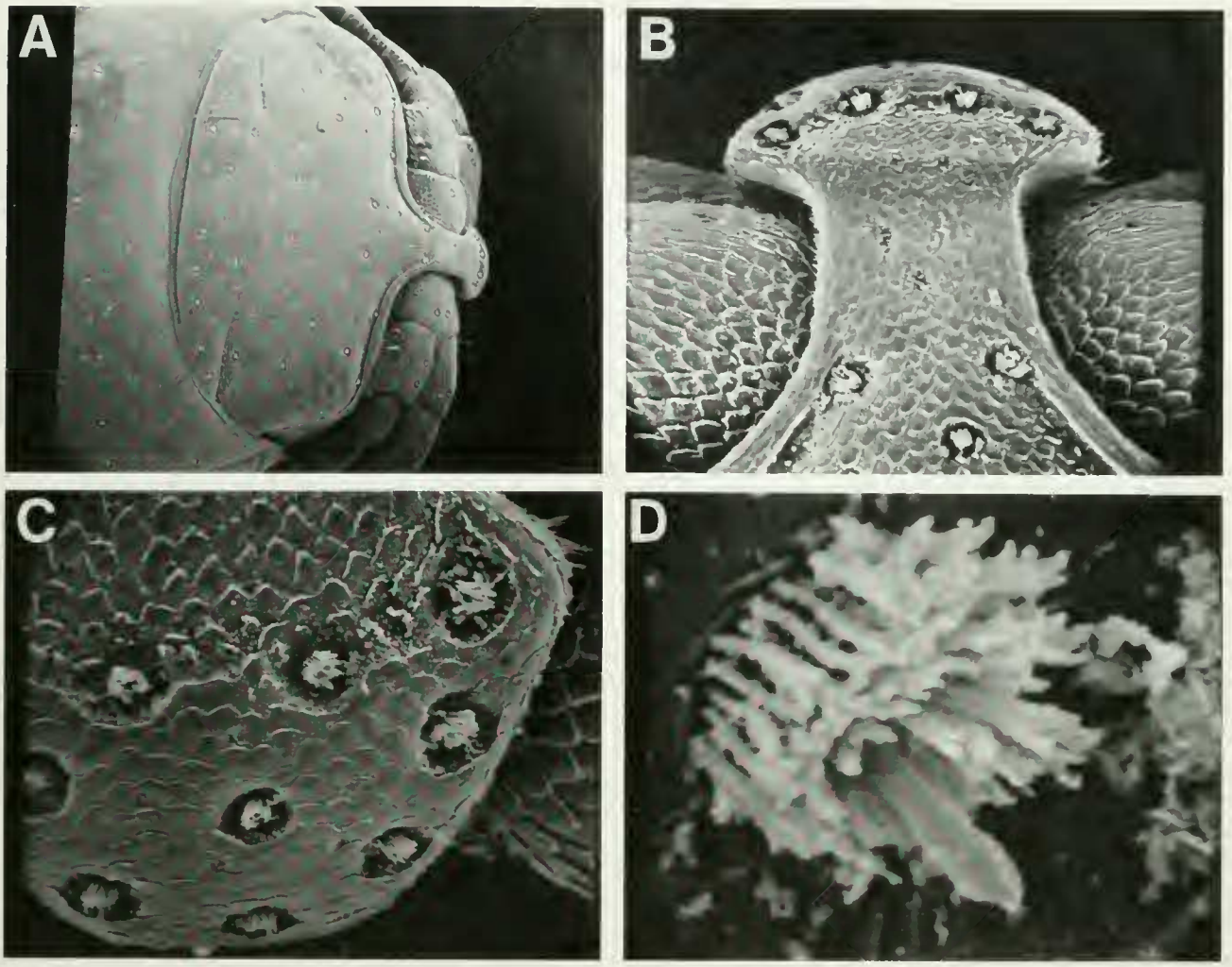

Figure 53. *Excirolana mayana*, scanning electron micrographs: A, cephalon, 74×. B, rostrum, 370×. C, anterior view of rostrum, 700×. D, rostral setae, 192×.

Bruce (1986a) noted that *Metacirolana* can be identified by the projecting clypeus, anteriorly dilated frontal lamina (often visible in dorsal view), pleonal and mouthpart morphology, and the long second article of the antennular peduncle. While in many species the second peduncular article is long, in *M. costaricensis*, *M. calypso* n. sp., and *M. joanneae* (and possibly others) the third peduncular article is the longest. However, none of these characters is unique to the genus. A possibly unique feature of *Metacirolana* is the small accessory tooth on the medial (inner) side of the right mandibular incisor, giving the incisor a four-pronged appearance. This condition occurs in at least *M. calypso* n. sp., *M. costaricensis* Brusca and Iverson, 1985, *M. basteni* Bruce, 1980, *M. bicornis* (Kensley, 1978), and *M. japonica* (Hansen, 1890) (see Bruce 1986a). Many published drawings of *Metacirolana* mandibles show this accessory tooth, but most authors have not indicated whether the figured mandible is the left or right. Bruce (1980, 1986a) apparantly confused the left and right mandibles in his figures and descriptions.

Nierstrasz (1931) created the name *Metacirolana* for *Cirolana japonica* Hansen, 1890, and *Cirolana hanseni* Bonnier, 1896. However, he did not designate a type species, thus rendering his name invalid (ICZN Article 13b). Kussakin (1979) was the first to designate a type species and thus stands as the valid author of the genus.

World list of species.—

1. *M. agaricicola* Kensley, 1984. Belize.
2. *M. agujae* Müller, 1991. Atlantic Colombia.
3. *M. anatola* Bruce, 1986. Queensland, Australia.
4. *M. anocula* (Kensley, 1984). South Africa.
5. *M. arnaudi* Kensley, 1989. St. Paul and Amsterdam islands, southern Indian Ocean.
6. *M. basteni* (Bruce, 1980). Australia.
7. *M. bicornis* (Kensley, 1978). South Africa.
8. *M. calypso* n. sp. Galapagos Islands, Ecuador.
9. *M. convexissima* (Kensley, 1984). South Africa.
10. *M. costaricensis* Brusca and Iverson, 1985. Pacific Costa Rica.
11. *M. fishelsoni* (Bruce and Jones, 1978). Red Sea.
12. *M. halia* Kensley, 1984. Cozumel (Mexico), Belize, and throughout Caribbean.
13. *M. hanseni* (Bonnier, 1896). Europe.
14. *M. japonica* (Hansen, 1890). Japan, Australia, Tasmania, and New Guinea.
15. *M. joanneae* (Schultz, 1966). California.
16. *M. mbudya* Bruce, 1981. Tanzania.

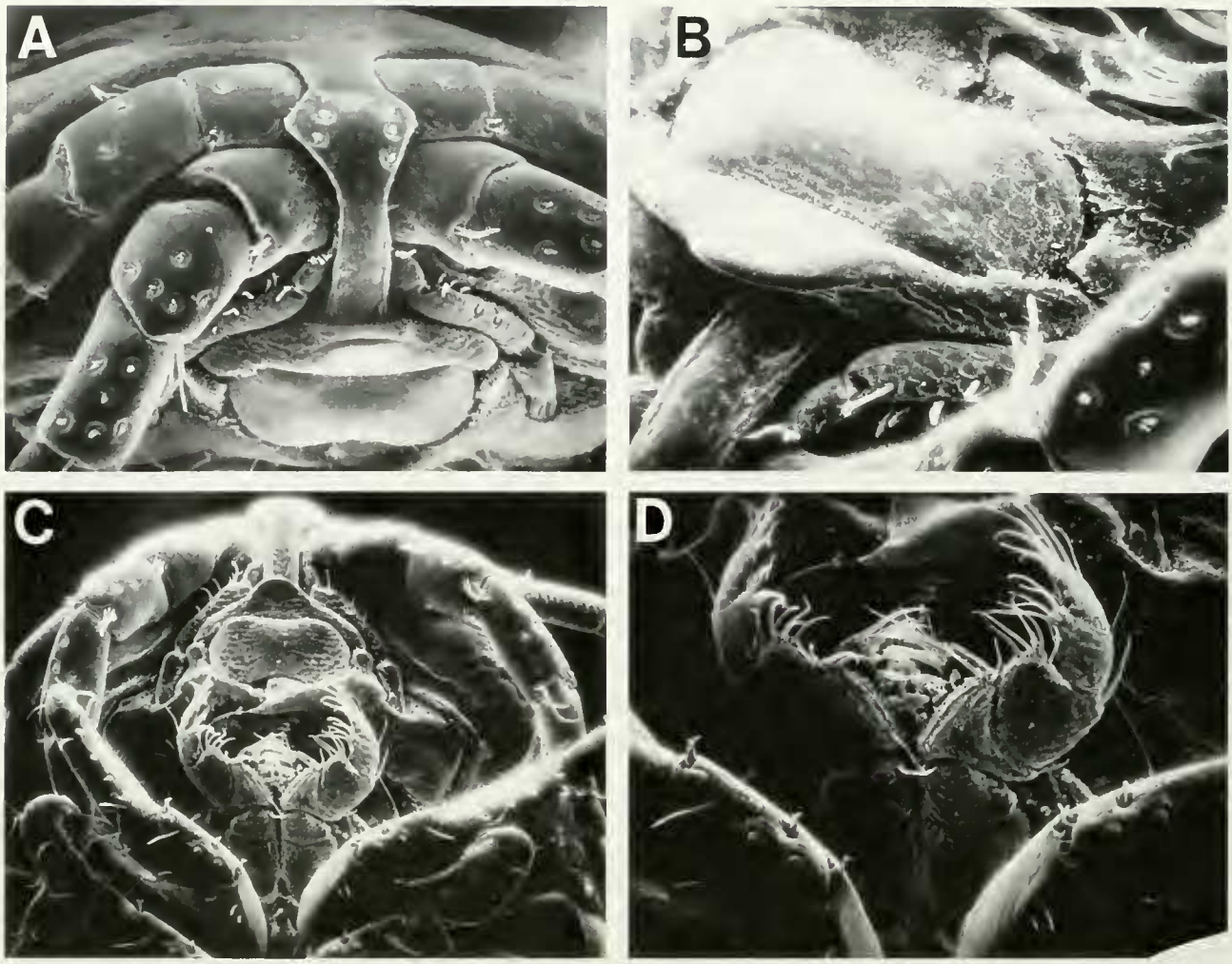

Figure 54. *Excirolana mayana*, scanning electron micrographs: A, rostrum and frontal lamina, 178×. B, clypeus and labrum, 285×. C, buccal field, 96×. D, maxillipeds, 192×.

17. *M. menziesi* Kensley, 1984. Belize.
18. *M. miyamotoi* Nunomura, 1991. Japan.
19. *M. monodi* (Jones, 1976). Aldabra.
20. *M. moortgati* Müller and Salvat, 1993. French Polynesia.
21. *M. nana* (Bruce, 1980). Australia.
22. *M. pigmentata* Müller and Salvat, 1993. French Polynesia.
23. *M. ponsi* Jaume and Garcia, 1992. Balearic Islands, Mediterranean Sea.
24. *M. riobaldoi* (Lemos de Castro and Lima, 1976). Brazil.
25. *M. rotunda* (Bruce and Jones, 1978). Red Sea to Tanzania.
26. *M. rugosa* (Bruce, 1980). Great Barrier Reef, Australia.
27. *M. serrata* (Bruce, 1980). Lizard Island, Australia.
28. *M. sphaeromiformis* (Hansen, 1890). Florida, Caribbean Sea, Indian Ocean, and possibly central/west Pacific Ocean.
29. *M. spinosa* (Bruce, 1980). Lizard Island, Australia.

Key to Tropical Eastern Pacific *Metacirolana* Species

1. Pleotelson of male without dorsal tubercles or carinae; posterior margin of pleotelson broad, convex, and strongly serrate; pereopod 1's merus with long acute spines on inferior margin; uropodal endopod shorter than pleotelson .....*M. calypso* n. sp.
— Pleotelson of male with dorsal tubercles or carinae; posterior margin of pleotelson narrow, subtruncate, and not serrate; pereopod 1's merus with squamate molariform spines on inferior margin; uropodal endopod extends to pleotelson apex .....*M. costaricensis*

Metacirolana calypso n. sp.
Figs. 60C, 61, 62

Type material examined.—Male holotype (LACM 84-287.1): Ecuador, Galapagos Islands, near Wolf Island (approx. 1° 18' N, 91° 45' W), neuston tow, 0545–0610 hrs.; 12 May 1984; coll. R. J. Lavenberg et al.; bottom depth not recorded by collectors but estimated (R. Lavenberg, in litt.) as approximately 2000 m.

Description of male.—Entire dorsum with striking ornate chromatophore pattern (Fig. 60C). Cephalon length, from rostrum to posterior margin, 1.5 times length of pereonite I; lateral margins evenly convex, not forming subacute angles. Cephalon devoid of dorsal tubercles or carinae; rostrum very short, rounded anteriorly (Fig. 60C). Antennule not quite reaching posterior margin of pereonite I; flagellum of 6 articles (Fig. 61A). Antenna extends to posterior margin of pereonite VII; flagellum of 14 articles (Fig. 61B). Frontal lamina narrow, almost quadrate posteriorly, expanded anteriorly to partly overlap proximal antennular article (Fig. 61C).

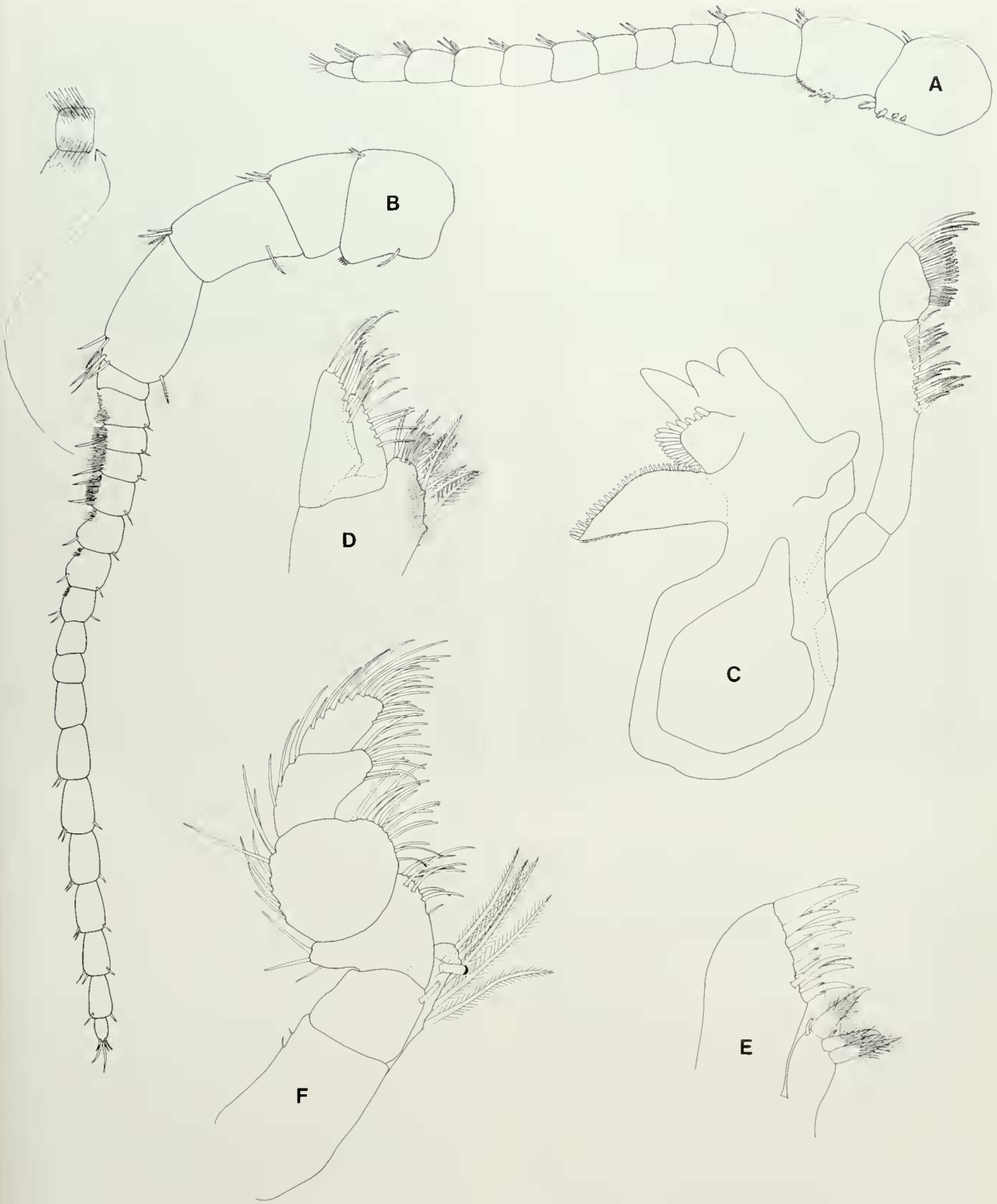

Figure 55. *Excirolana mayana*. A, B (Mexico, Sonora, Puerto Peñasco), adult: A, antennule (left). B, antenna (left). C–F (Mexico, Baja California Sur, Concepción Bay), juvenile: C, mandible (right). D, maxilla (right). E, maxillule (right). F, maxilliped (right). All drawings from female specimens.

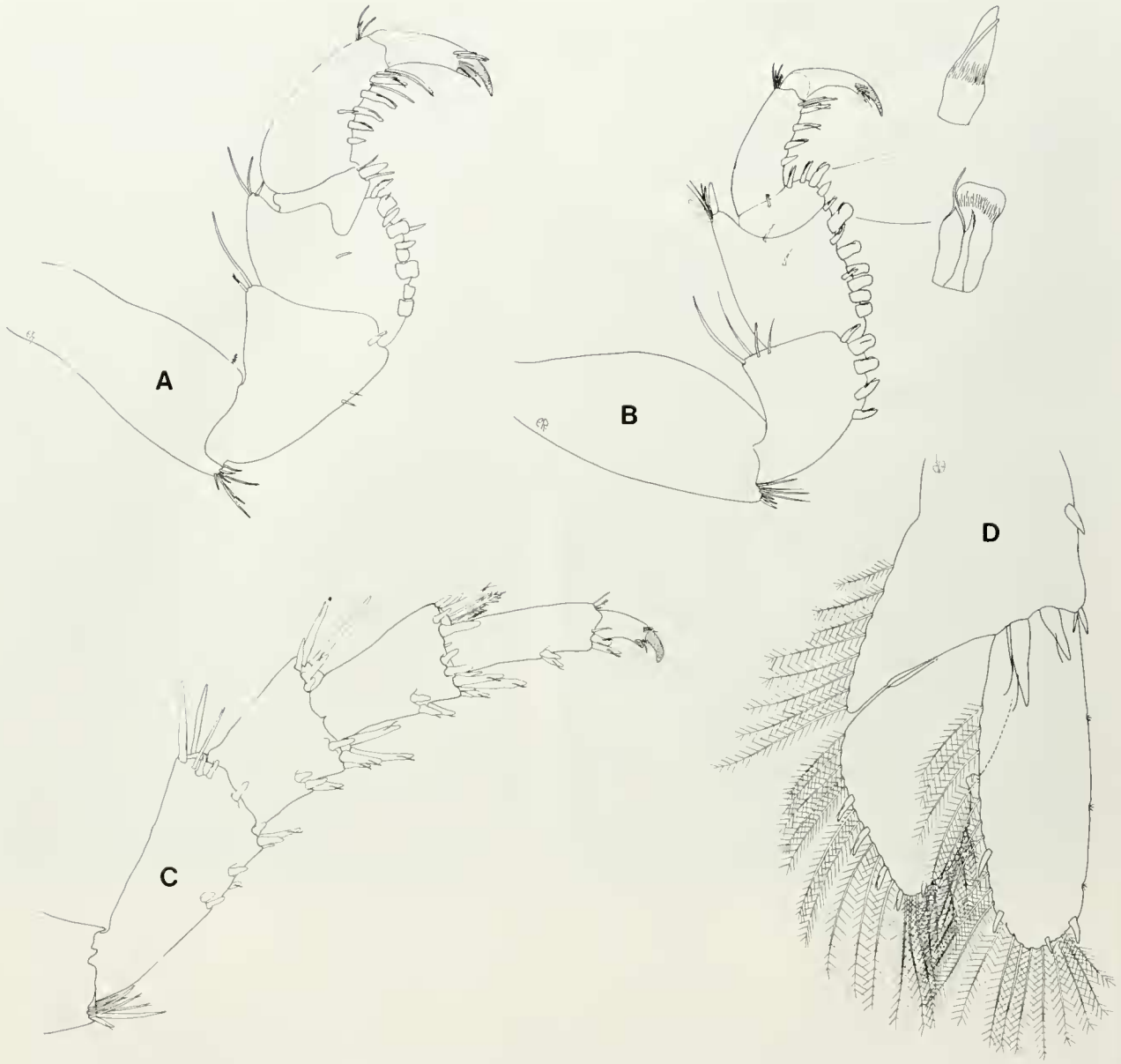

Figure 56. *Excirolana mayana* (Mexico, Sonora, Puerto Peñasco, 17 June 1972), adult: A, pereopod I (left). B, pereopod III (left). C, pereopod VII (left). D, uropod (left).

Mandibular spine row with 19 long thin spines; molar process with about 20 small marginal spines; terminal article of palp with simple setae and 1 comb seta; middle article longest, with simple and comb setae (Fig. 61D). Maxillule's lateral lobe with 12 stout spines, largest spines armed with barbs; medial lobe with 1 small apical seta in addition to the 3 circumplumose spines (Fig. 61E). Maxilla's lateral lobes with 3 and 5 plumose setae, respectively; medial lobe with 1 simple and 7 plumose setae (Fig. 61F). Maxillipedal palp articles 4 and 5 are margined with plumose setae, other articles with simple setae; left and right endites small, each with 1 coupling spine and 4 plumose setae (Fig. 61G).

Pereonites unequal in length, pereonite 1 longest; pereon widest at pereonites IV and V, devoid of dorsal tubercles or carinae. Coxae usually visible dorsally, extending beyond posterior margins of their respective segments; coxa VII extends almost to posterior margin of pleonite 2 (Fig. 60C). Pereopod I short, stout; superior distal angles of ischium and merus each with 1 long seta; inferior margins of merus, carpus, and propodus with acute spines as figured; inferior margin of propodus also with 1 serrate spine; carpus short; dactylus without small spine at base of unguis (Fig. 62A). Pereopod IV longer than pereopod I, ambulatory, with simple and serrate spines and setae as figured; dactylus without small spine(s) at base of unguis (Fig. 62B). Pereopod VII quite long, ambulatory, with simple and serrate spines and setae as figured (Fig. 62C). Penes large, about 6 times longer than wide, extended roughly 0.66 length of sternite.

Pleon broadest at pleonite 2, devoid of dorsal tubercles or carinae. Pereonite VII's coxae overlap lateral margins of pleonite 1; pleonites 2–4 expanded laterally (Fig. 60C). Pleopod rami with PMS as figured (Figs. 62F-J). Pleopod 1: peduncle's medial margin with 4 coupling spines, lateral margin with 2 simple spines;

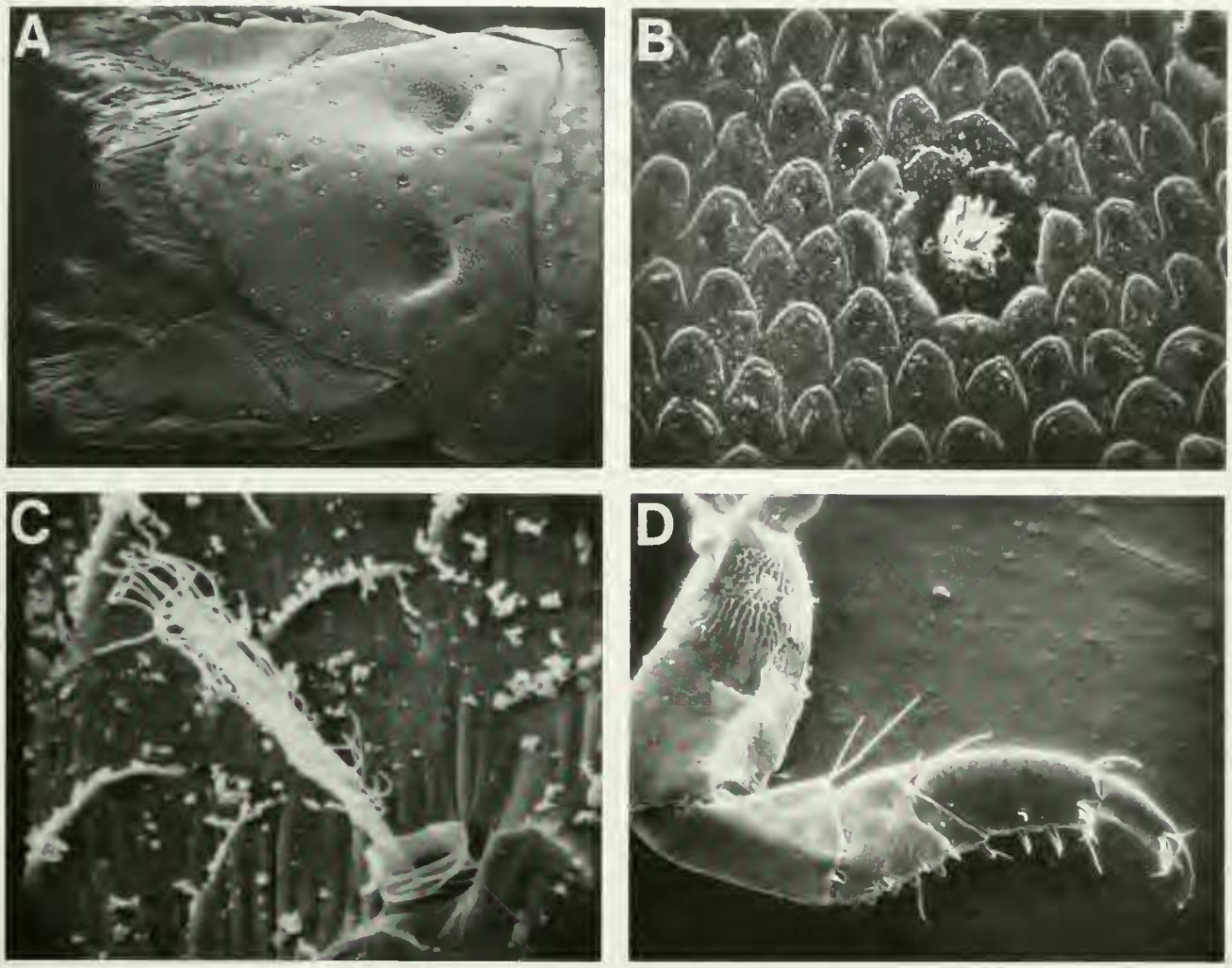

Figure 57. *Excirolana mayana*, scanning electron micrographs: A, pleotelson, 74×. B, seta next to right depression on pleotelson, 462×. C, seta in right depression on pleotelson, 3330×. D, pereopod, 96×.

endopod width 0.68 times width of exopod (Fig. 62F). Pleopod 2: peduncle's medial margin with 2 coupling spines, 2 plumose setae, and many short simple setae; lateral margin with 1 simple spine; endopod width 0.85 times width of exopod; appendix masculina widest basally, tapering to serrate medial margin near pointed apex, medial margin with many small setae, length 0.95 times endopod length (Fig. 62G). Pleopod 3: peduncle's medial margin with 3 coupling spines and 1 plumose seta, lateral margin with 1 simple spine; endopod width 0.72 times exopod width, exopod with short marginal incisions (Fig. 62H). Pleopod 4: peduncle's medial margin with 3 coupling spines and 1 plumose seta, lateral margin with 1 simple spine and many short setae; endopod 0.73 times width of exopod, exopod with complete medial incision (Fig. 62I). Pleopod 5: peduncle smaller than peduncles of pleopods 1–4, with 1 simple spine and many short setae on lateral margin; endopod width 0.80 times exopod width; exopod with complete medial incision (Fig. 62J).

Pleotelson with straight lateral margins, apex widely rounded with sharply crenulate (saw-toothed) margin; without apical spines but with PMS; dorsum without longitudinal carinae (Fig. 60C). Uropods shorter than pleotelson, with small terminal notch on each ramus, 5–7 simple setae arising from each notch. Uropodal exopod 0.70 times as wide as endopod, shorter than endopod, medial margin with 1 short spine and many PMS, lateral margin with 3 short spines and setae. Uropodal endopod's medial margin with 2 short spines and many PMS, lateral margin with 1 short spine and many PMS. Uropodal peduncle with short apical spine, medial margin with PMS (Fig. 60C).

Female.—Not known.

Size.—Small, holotype 5.2 mm long.

Distribution.—So far known from only the type locality, near Wolf Island, the Galapagos Islands, Ecuador.

Remarks.—This species is immediately distinguished from the only other known eastern Pacific *Metacirolana* (*M. costaricensis*) by features noted in the key. It is known from only a single specimen collected in a neuston (surface) plankton tow near Wolf Island in the Galapagos Islands. However, the distinct morphology of the specimen warrants formal species recognition.

Etymology. — This species is named after Calypso, daughter of Oceanus in Greek mythology. Just as this beautiful island isopod charmed its describers, the charms of the island nymph Calypso were so powerful they detained Odysseus seven years on his journey home from Troy.

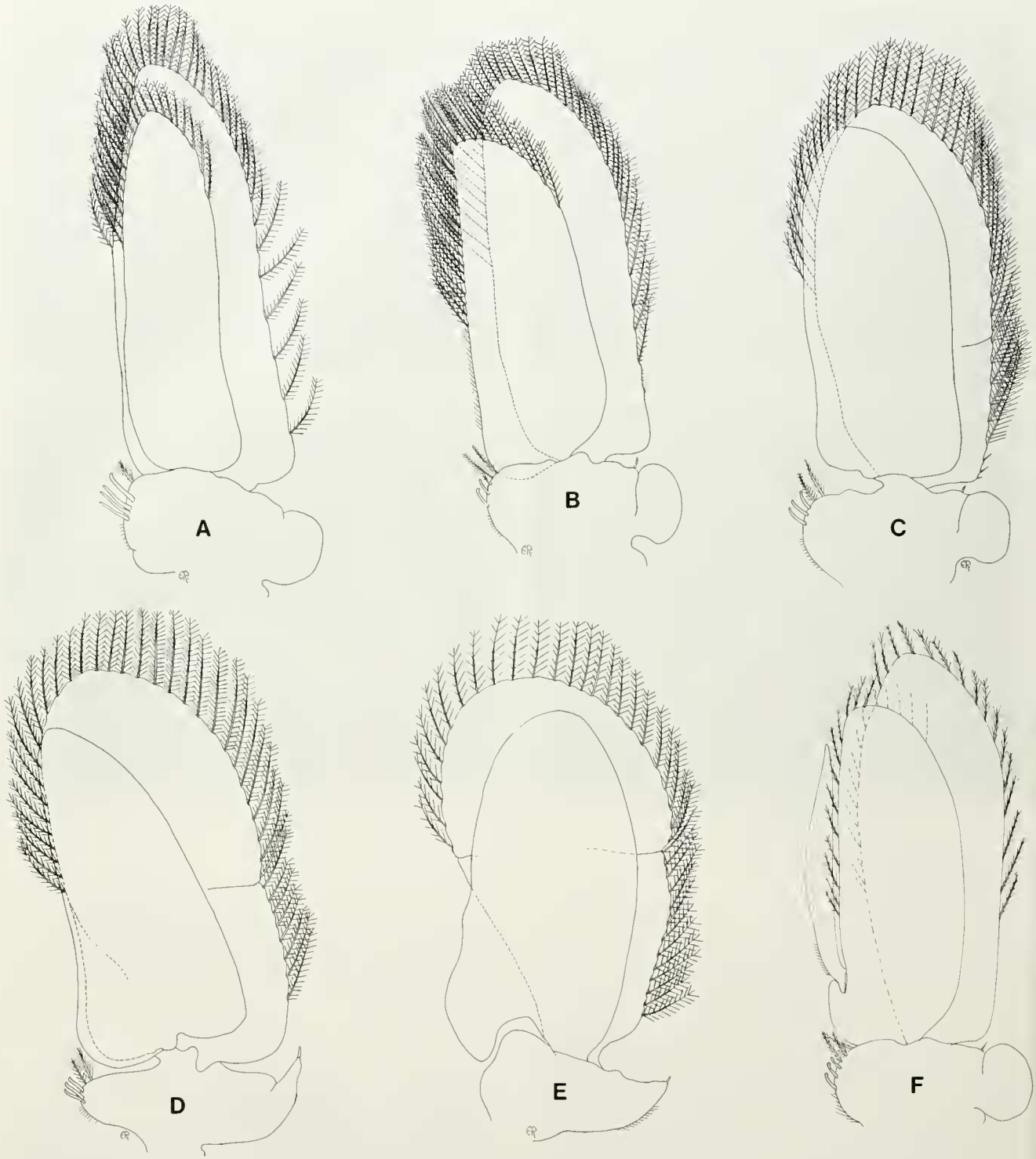

Figure 58. *Excirolana mayana*. A–E (Mexico, Sonora, Puerto Peñasco), pleopods of adult female: A, pleopod 1 (left). B, pleopod 2 (left). C, pleopod 3 (left). D, pleopod 4 (left). E, pleopod 5 (left). F (Mexico, Gulf of California, Cerralvo Island), adult male, pleopod 2 (left).

Metacirolana costaricensis Brusca and Iverson, 1985
Figs. 60A, B, 63, 64

Metacirolana costaricensis Brusca and Iverson 1985: 36, Fig. 11D. Bruce 1986a: 222.

Type material examined.—Holotype (LACM 80-60.1, AHF Type No. 8011) and 15 paratypes (LACM 80-60.2): Costa Rica, Guanacaste Province, Parque Nacional Santa Rosa, rocky littoral approximately 1 km from mouth of mangrove estuary, ca. 10° 48' N, 86° 57' W, formalin washes of rocks and turf algae, water temperature 26° C, large surf; 26 Apr. 1980; coll. R. C. Brusca, A. M. Mackey, M. Murillo, A. Dittle.

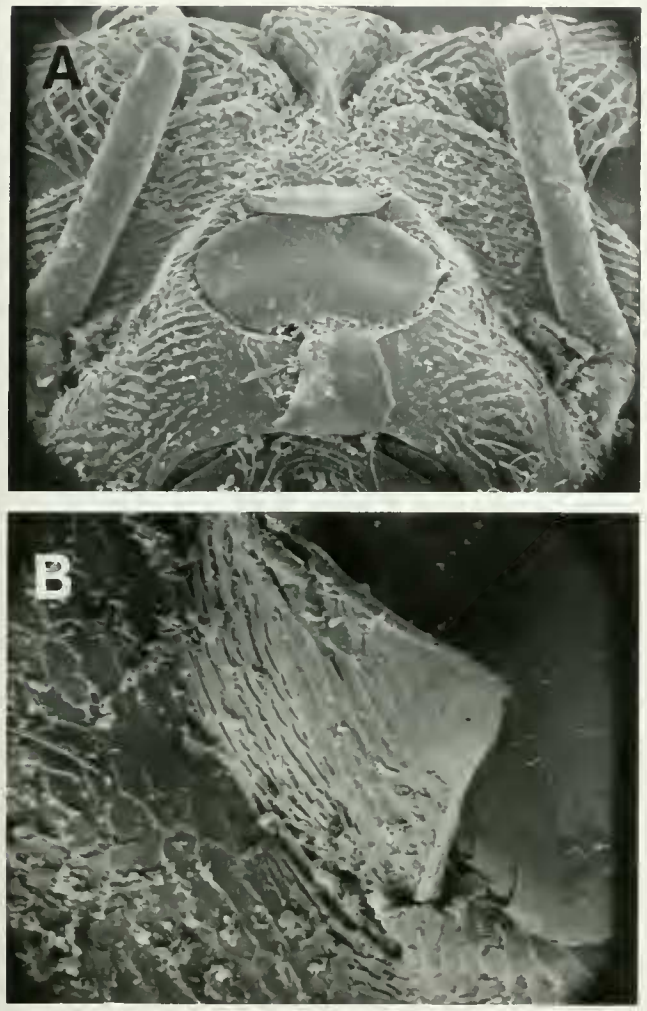

Figure 59. *Metacirolana joannae* (AHF 2250-1), scanning electron micrographs: A, ventral view of frontal lamina, clypeus, and labrum, 118×. B, ventrally projecting clypeus, 370×.

Other material examined.—Central American specimens: (1) Costa Rica, Puntarenas Province, just outside mouth of Gulf of Nicoya, Playa Tárcoles, 9° 45' N, 84° 50' W, dark sand with scattered rocky points, formalin washes of rocks and associated sediment, onuphid polychaete tubes abundant, water temperature 29° C; SDNHM; 22 Feb. 1980; coll. R. C. Brusca; 29 specimens. (2) Costa Rica, Puntarenas Province, Panama Bay, "infauna, 2 meters marea alto, transect #2 (Vallejo), station #2"; SDNHM; 3 Feb. 1977; 2 specimens (gift of M. M. Murillo). (3) Panama, Culebra Island; PWG-67, SDNHM; 23 Jan. 1967; coll. P. W. Glynn; 1 female.

Galapagos specimens: (4) Just west of Isabela Island, 0° 15' 43" S, 91° 26' 38" W, taken by hand; R/V *Anton Bruun* Cruise 16; 25 May 1966; SEPBOP program; 9 specimens (Sta. ST66142); 3 males and 1 female (Sta. ST66141) (precise coordinates questionable). (5) Wolf Island, on shore with green algae; Sta. 144, USNM Acc. No. 128938; 11 Jan. 1934; 1 male. (6) South side of Pinta Island, near Ibbetson Point, 0° 32' 25" N, 90° 43.5' W, near national park marker on shore, noon, low tide, large shallow tidepool, fixed lava rock with loose lava stones and some sand, 0–1 ft. standing water, from under loose rocks; LACM; 20 May 1984; coll. A. Cohen; 6 specimens. (7) Tower Island, tidepool on north side of Darwin Bay, 0° 18' 58" N, 90° 57' 23" W, lava rock in large pool 3 m deep with deeper crevices, low tide, under loose rubble (rock and dead coral) in exposed (low tide) channel at entrance to pool; AC-GAL-27, LACM; 21 May 1984; coll. A. Cohen; 2 specimens. (9) no precise locality; AC-GAL-8-A, LACM; 1984; coll. A. Cohen; 1 specimen.

Description of male.—Cephalon devoid of tubercles and carinae; length from posterior margin to rostrum subequal to length of pereonite I, rostrum moderate in size; lateral margins forming subacute angles (Fig. 60A). Antennule short, reaching posterior margin of cephalon; flagellum of 3–6 articles, distal flagellar articles compressed and short (Fig. 63A). Antenna reaching pereonite II; peduncular articles 1 and 2 partially fused; flagellum of 8–12 articles (Fig. 63B). Frontal lamina narrow posteriorly, expanded and rounded anteriorly; anterior expansion overlaps basal articles of antennules (Fig. 63C). Both mandibular incisors tridentate; right incisor with accessory tooth; left incisor indistinctly tridentate, somewhat bladelike and without accessory tooth; spine row with 14 long thin spines; palp 3-articulate, terminal article with comb setae, middle article longest and with simple and comb setae (Fig. 63D). Maxillule's medial lobe with 1 small apical spine, in addition to the 3 circumplumose spines; lateral lobe with 10 stout spines, many strongly barbed (Fig. 63E). Maxilla's medial lobe with 6 plumose, 1 large circumplumose, and 2 small simple setae; lateral lobes with 3 comb and 4 plumose setae, respectively (Fig. 63F). Maxillipedal palp articles subrectangular, margins with many long simple and comb setae; endite small, with 2 plumose setae and 1 simple seta, with 1 or 2 coupling spines (usually 2) on both left and right endites; small epipod present in both sexes (Fig. 63G).

Pereon widest at pereonites V and VI, devoid of dorsal tubercles or carinae. Pereonite VII with short rounded process on posterolateral margins. Coxae III–VI carinate, visible in dorsal view and extending beyond posterior margins of their respective pereonites; coxa VII large, extending to posterior margin of pleonite 5 (Fig. 60A). Pereopod I short and stout; distal margins of articles not produced; inferior margin of merus with 3 very short blunt squamate spines, 2 simple setae, and 1 small serrate spine; carpus very short, inferior margin with 1 squamate spine, 1 serrate spine, and 3 simple setae; inferior margin of propodus with 3 large basally serrate spines and simple setae; dactylus with 1 small simple spine at base of unguis (Fig. 64A). Pereopod IV short, stout, ambulatory, with simple spines and setae as figured (Fig. 64B). Pereopod VII ambulatory with simple and serrate spines and setae as figured (Fig. 64C). Penes about 3 times longer than wide.

Pleon broadest at pleonites 3 and 4. Pleonite 1 overlapped laterally by pereonite VII, visible medially. Pleonite 5 with large median tubercle on posterior margin (Fig. 60A). Pleopodal rami with PMS as figured (Figs. 64F-J). Pleopod 1: peduncle's medial margin with 4 coupling spines, lateral margin with 1 seta; endopod width 0.6 times width of exopod (Fig. 64F). Pleopod 2: peduncle's medial margin with 4 coupling spines and 2 plumose setae, lateral margin with 1 long and many short setae; endopod width 0.7 times width of exopod; appendix masculina widest basally, tapering medially and widening again near apex, length 0.8 times endopod length (Fig. 64G). Pleopod 3: peduncle's medial margin with 4 coupling spines and 2 plumose setae; endopod width 0.74 times exopod width (Fig. 64H). Pleopod 4: peduncle's medial margin with 4 coupling spines and 2 plumose setae, lateral margin with 1 large spine and 1 short spine; endopod width 0.80 times exopod width (Fig. 64I). Pleopod 5: peduncle's lateral margin with 1 simple spine; endopod width 0.82 times exopod width (Fig. 64J). Pleopodal exopods 3–5 with complete or nearly complete medial transverse incision.

Pleotelson subtriangular, lateral margins slightly concave near truncate apex; dorsum with median longitudinal carina, flanked by

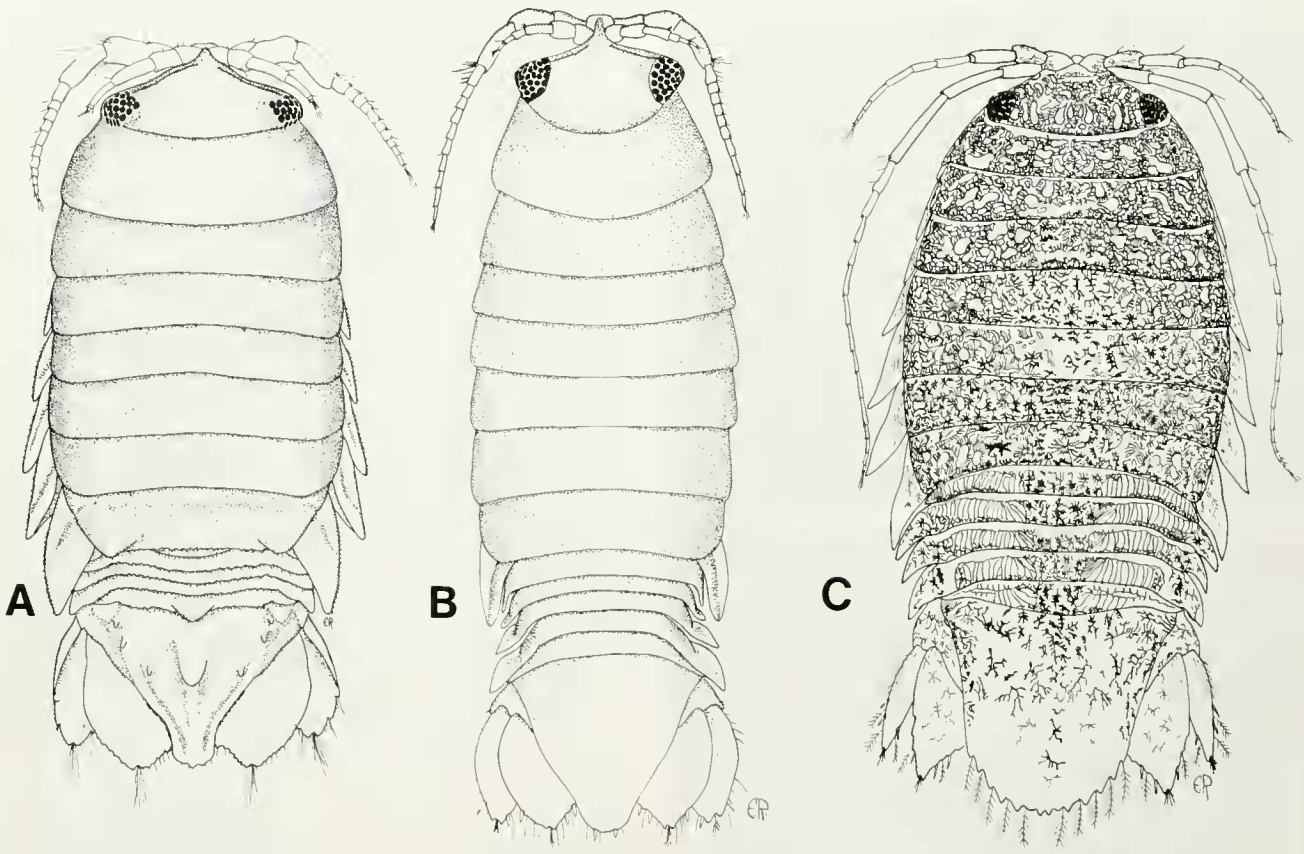

Figure 60. *Metacirolana* of the tropical eastern Pacific, dorsal views: A, *M. costaricensis* (LACM 80-60.1), holotype, male. B, *M. costaricensis* (LACM 80-60.2), paratype, female. C, *M. calypso* n. sp. (LACM 84-287.1, GAL 84-10), holotype, male.

submedian longitudinal carinae, carinae usually with tubercles; pleotelson apex with 2 marginal spines and several simple setae (Fig. 60A). Uropods with small apical notch on each ramus, 6 or 7 PMS arising from each notch. Uropodal exopod does not extend to pleotelson apex, 0.66 width of endopod, medial margin with 2 large spines interspersed with PMS, lateral margin with 2 small spines, simple setae, and PMS. Uropodal endopod extends to pleotelson apex; medial margin with 3 spines interspersed with PMS and some simple setae; lateral margin with 1 spine and PMS (Fig. 64E).

Female.—Similar to male, except dorsal tuberculation on the pleon and pleotelson is reduced or absent, the pleotelson's lateral margins are straighter and not as concave as in males, coxal plates II–VI are less visible in dorsal view, and pleonite 1 is not necessarily hidden by pereonite VII (Fig. 60B).

Size.—Small, to maximum length of 4.0 mm.

Distribution.—Thus far recorded from Pacific Costa Rica, Panama, and the Galapagos Islands. Material examined is, with the exception of the two *Anton Bruun* lots, all littoral. The *Anton Bruun* Galapagos records suggest that the specimens were taken in deep water, but the station numbers on label data do not occur in the station lists of Chin et al. (1972).

Remarks.—An intertidal and shallow subtidal species, found in rocky littoral areas with turf-algae and in dark sandy/rocky habitats. Brusca and Iverson (1985) did not adequately figure this species, so we illustrate it completely here.

Natatolana Bruce, 1981

Type species.—*Cirolana hirtipes* Milne Edwards, 1840, by subsequent designation (Bruce 1981a). Type specimens at the Muséum National d'Histoire Naturelle, Paris.

Synonymy.—Emended and subsequent to Bruce (1986a:52).

Natatolana. Bruce 1985: 708. Brusca and Iverson 1985: 37. Botosaneanu et al. 1986: 412. Kensley and Schotte 1989: 139.

Description.—Body length approximately 2.5–3.0 times width; dorsum smooth, without ornamentation. Eyes usually well developed, but absent or with reduced ommatidia in some species. Rostral process minute or absent. Frontal lamina elongate, narrow, flat, not projecting, length 3–4 times width; clypeus broad, wider than long, flat (sessile); labrum narrower than clypeus. Antennular peduncle and flagellum short, flagellum does not extend beyond anterior region of pereonite I; second article not articulated at right angle to first article (as in *Eurydice*); peduncular article 3 longest; flagellar articles compressed, basal articles often fused. Antennae much longer than antennules; peduncular articles 1–2 short, 3–4 subequal, 5 longest. Mandible with broad tridentate incisor, medial cusp often reduced on left mandible; spine row well developed as a rounded lobe with stout spines. Maxillule's medial lobe with 3 or 4 stout circumplumose spines and often a few small simple spines; lateral lobe with 9–12 stout apical spines, often with minute subapical lateral spines or barbs. Maxilla with medial lobe short and broad. Maxillipedal palp 5-articulate; endite short, with 1–3 coupling spines.

Pereonite 1 longest. Posterior angles of coxae II–VII become more acute posteriorly. Pereopodal dactyli often with small spine at base of ungui; superior margins of ischium and merus of pereopods I–III strongly produced; pereopods IV–VII longer than pereopods

Figure 61. *Metacirolana calypso* n. sp. (LACM 84-287.1, GAL 84-10), holotype, male: A, antennule (left). B, antenna (left). C, frontal lamina, clypeus, and labrum. D, mandible (right). E, maxillule (right). F, maxilla (right). G, maxilliped (right).

I–III and with abundant long setae; pereopods VI–VII with ischium–propodus flattened and provided with long setae; pereopod VII with dense medial row of long setae along flat anterior surface. Penes indistinct or represented by small flattened lobes.

Pleon of 5 free pleonites; pleonite 1 often partially concealed by pereonite VII; pleonite 5 completely encompassed by lateral margins of pleonite 4. Pleopod 1's exopod almost twice as wide as endopod; pleopodal peduncles broader than long, lateral margins without lobes or with weak lobes; rami similar; all pleopodal rami with PMS, except endopod of pleopod 5, which has reduced or no PMS; appendix masculina inserted basally or subbasally on endopod of male's pleopod 2. Pleopod 5: peduncle's medial margin without coupling spines or plumose setae; endopod with proximomedial lobe. Pleotelson usually with abundant marginal setae and spines. Uropodal peduncle's inner angle produced and subacute; rami with PMS and usually spines; endopod usually without notch on distal medial angle, except in *Natatolana variguberna*.

Remarks.—Bruce (1981a) split *Cirolana* into seven different genera, erecting three new genera, including *Natatolana*. He did not describe or figure *Cirolana hirtipes* Milne Edwards, 1840, the type species. Characters diagnostic of *Natatolana* include the glabrous appearance and absence of sculpturing of the dorsum, short antennules, flattened articles on the posterior pereopods, and the medial row of long setae on the flat anterior surface of pereopod VII. Similar-appearing genera are *Dolicholana* and *Politolana*. *Dolicholana* has similar pereopods but differs in the form of the frontal lamina, which has the ventral surface excavated and the posterior margin produced into a ventrally projecting lobe (the ventral surface of the frontal lamina is flat in *Natatolana*), and in the lack of PMS on pleopodal endopods (only the endopod of pleopod 5 is naked in *Natatolana*). *Politolana* differs from *Natatolana* in the following ways: the bases of the posterior pereopods are less expanded; the appendix masculina arise subbasally, rather than basally as in *Natatolana* (although in some species of *Natatolana* the appendix masculina arises slightly above the basal position—see *N.*

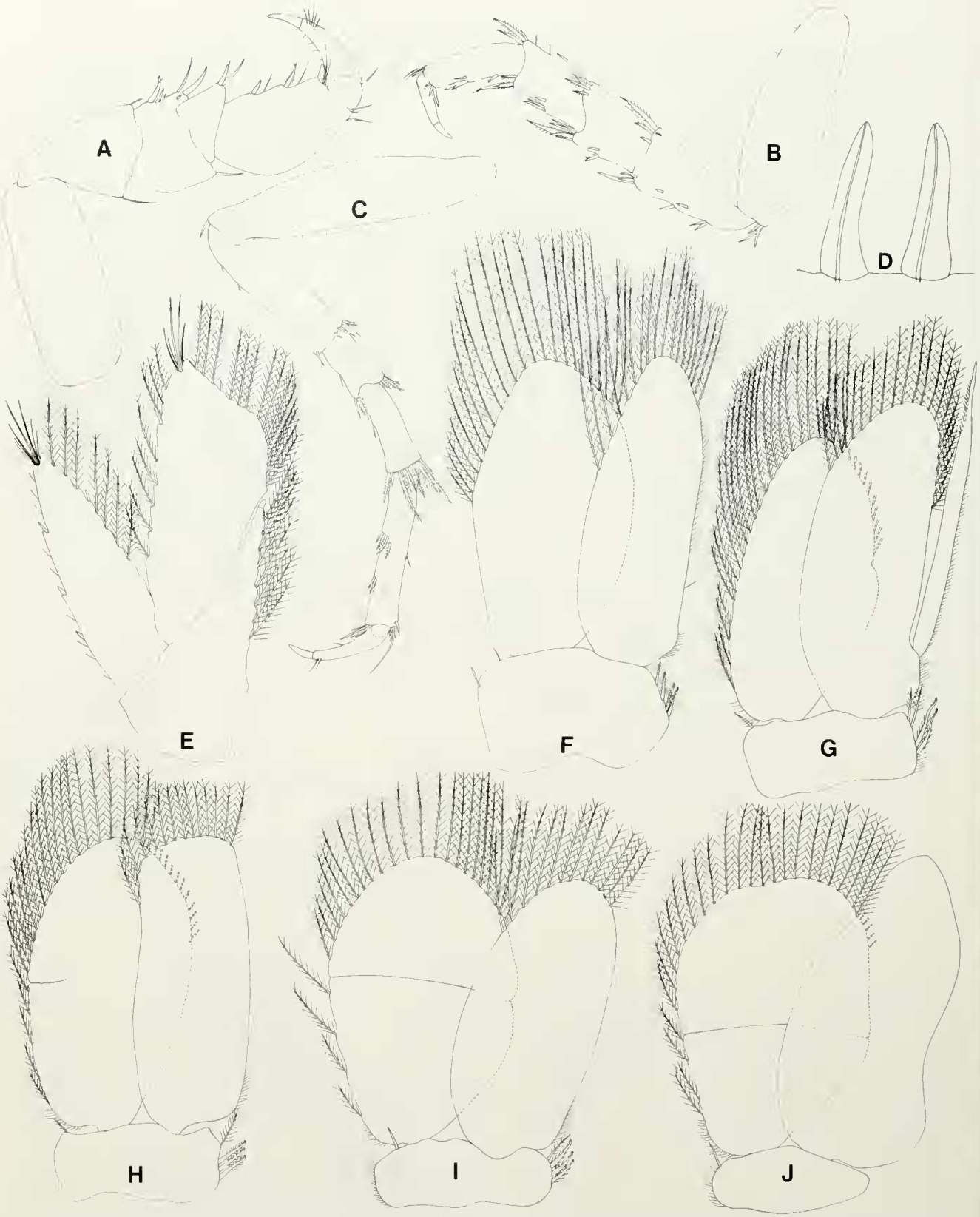

Figure 62. *Metacirolana calypso* n. sp. (LACM 84-287.1, GAL 84-10), holotype, male: A, pereopod I (right). B, pereopod IV (right). C, pereopod VII (right). D, penes. E, dorsal view of uropod (right). F, pleopod 1 (right). G, pleopod 2 (right). H, pleopod 3 (right). I, pleopod 4 (right). J, pleopod 5 (right).

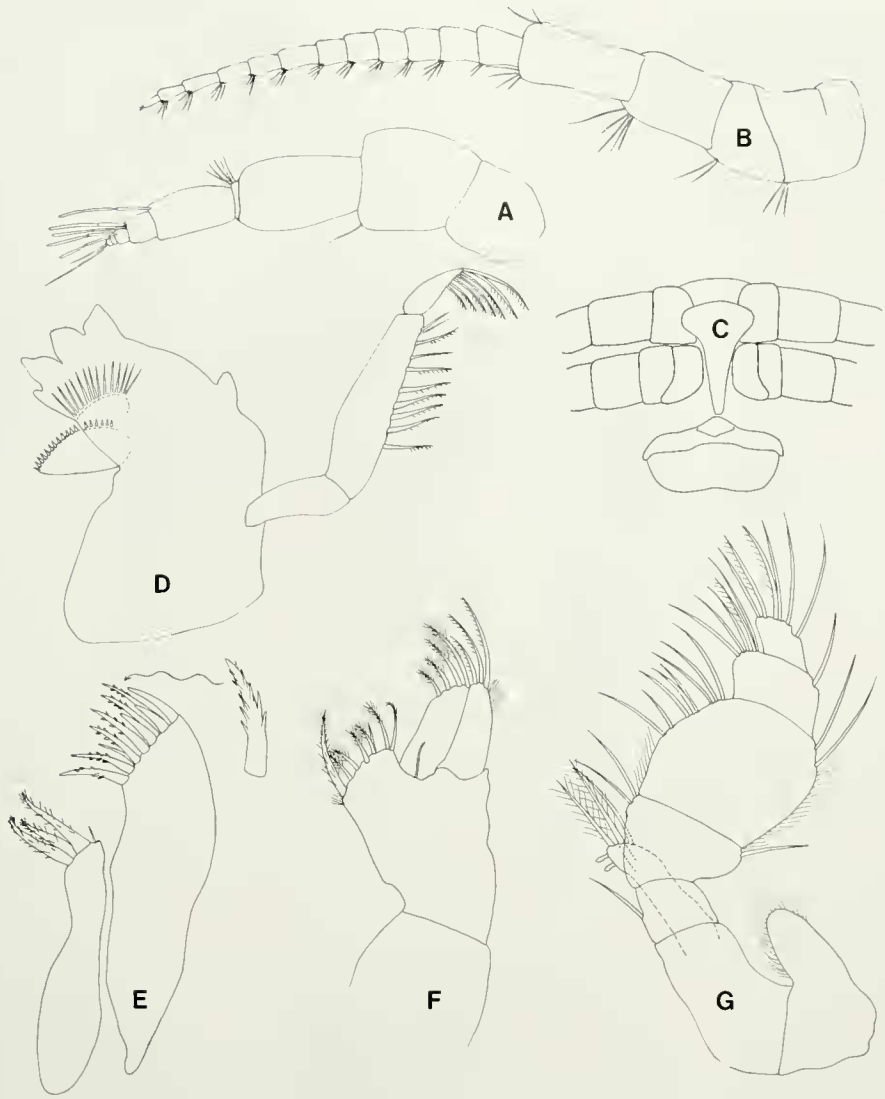

Figure 63. *Metacirolana costaricensis* (LACM 80-60.1), holotype, male: A, antennule (left). B, antenna (left). C, frontal lamina, clypeus, and labrum. D, mandible (right). E, maxillule (right). F, maxilla (right). G, maxilliped (right).

bowmani Bruce, 1986); pleopod 1's peduncle is subquadrate (it is wider than long in *Natatolana*); and the uropodal endopod has a distolateral notch (absent in *Natatolana*, except in *N. variguberna*). *Natatolana*, *Politolana*, and *Dolicholana* are part of Bruce's (1986a) "*Conilera* genus-group," along with *Conilera*, *Orphelana*, and *Conilorpheus*. Wetzer et al. (1987) discussed this group, provided a key to the genera, and removed *Oncilorpheus* from it.

Natatolana, with 58 described species, is the second largest genus in the family, and it has the widest distribution of any cirolanid genus, with more species known from temperate and cold waters than in any other genus. *Natatolana* is primarily a shelf and slope taxon, ranging from the shallow subtidal to about 2000 m, although occasional specimens have been collected intertidally. Bruce (1986a) divided the genus into four "species-groups," the *N. pellucida* group, the *N. valida* group, the *N. albicaudata* group, and the *N. woodjonesi* group. The groups are distinguished from one another by the basis of pereopod VII, the posterolateral margin of pleonite 4, the pleotelson dorsum, and the posterior margin of the pleotelson.

In all the species we have examined, it appears that the medial lobe of the maxillule in species with the 3-spine configuration also possesses a moderately to well developed protuberance on the lateral margin, whereas species with the 4-spine configuration lack this protuberance.

There are four *Natatolana* species in the eastern Pacific: *N. chilensis* (Menzies, 1962a), *N. natalis* (Menzies and George, 1972), *N. californiensis* (Schultz, 1966), and *N. carlenae* n. sp. Only the last two are tropical.

World list of species.—

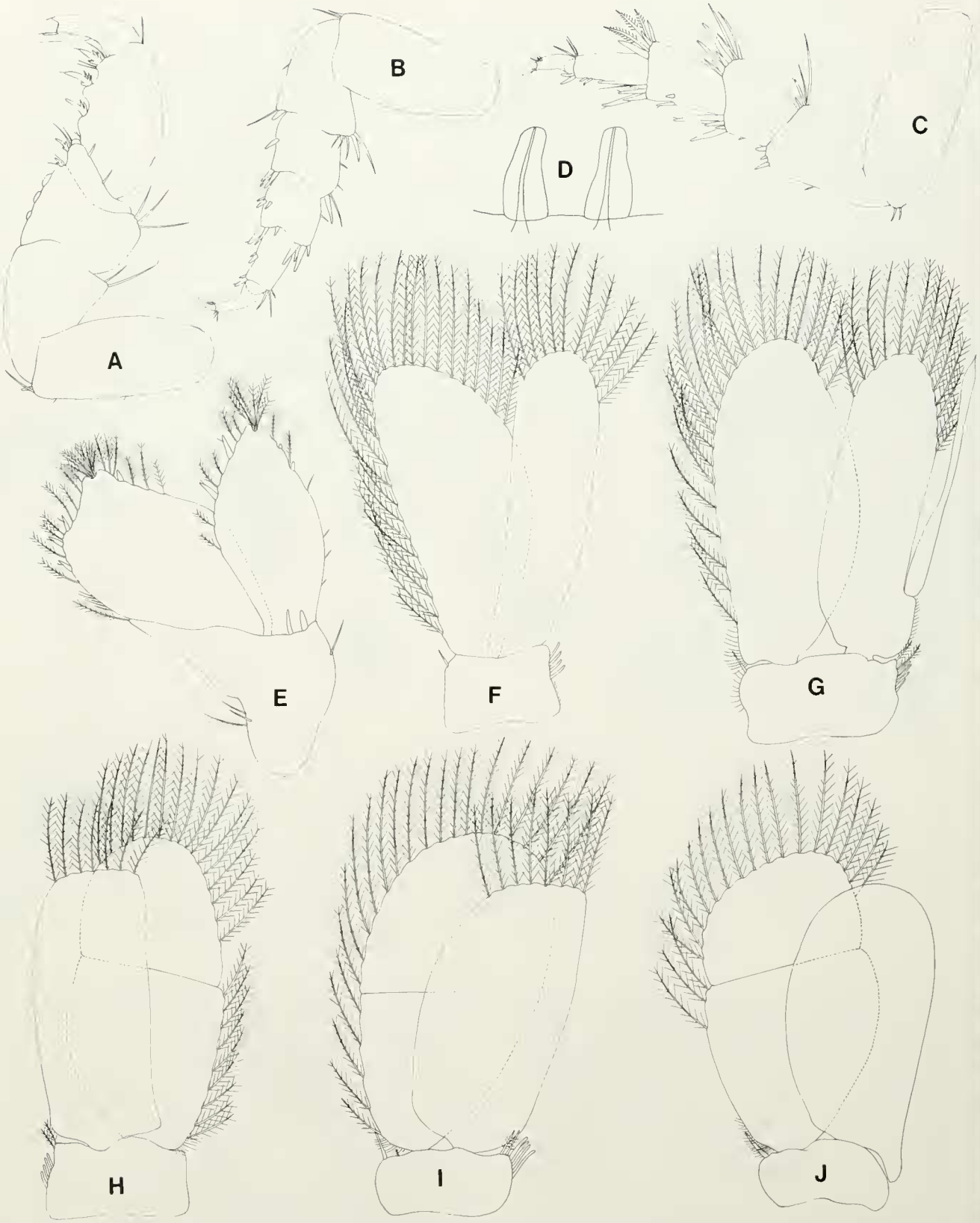

Figure 64. *Metacirolana costaricensis* (LACM 80-60.1), holotype, male: A, pereopod I (left). B, pereopod IV (left). C, pereopod VII (left). D, penes. E, ventral view of uropod (right). F, pleopod 1. G, pleopod 2. H, pleopod 3. I, pleopod 4. J, pleopod 5.

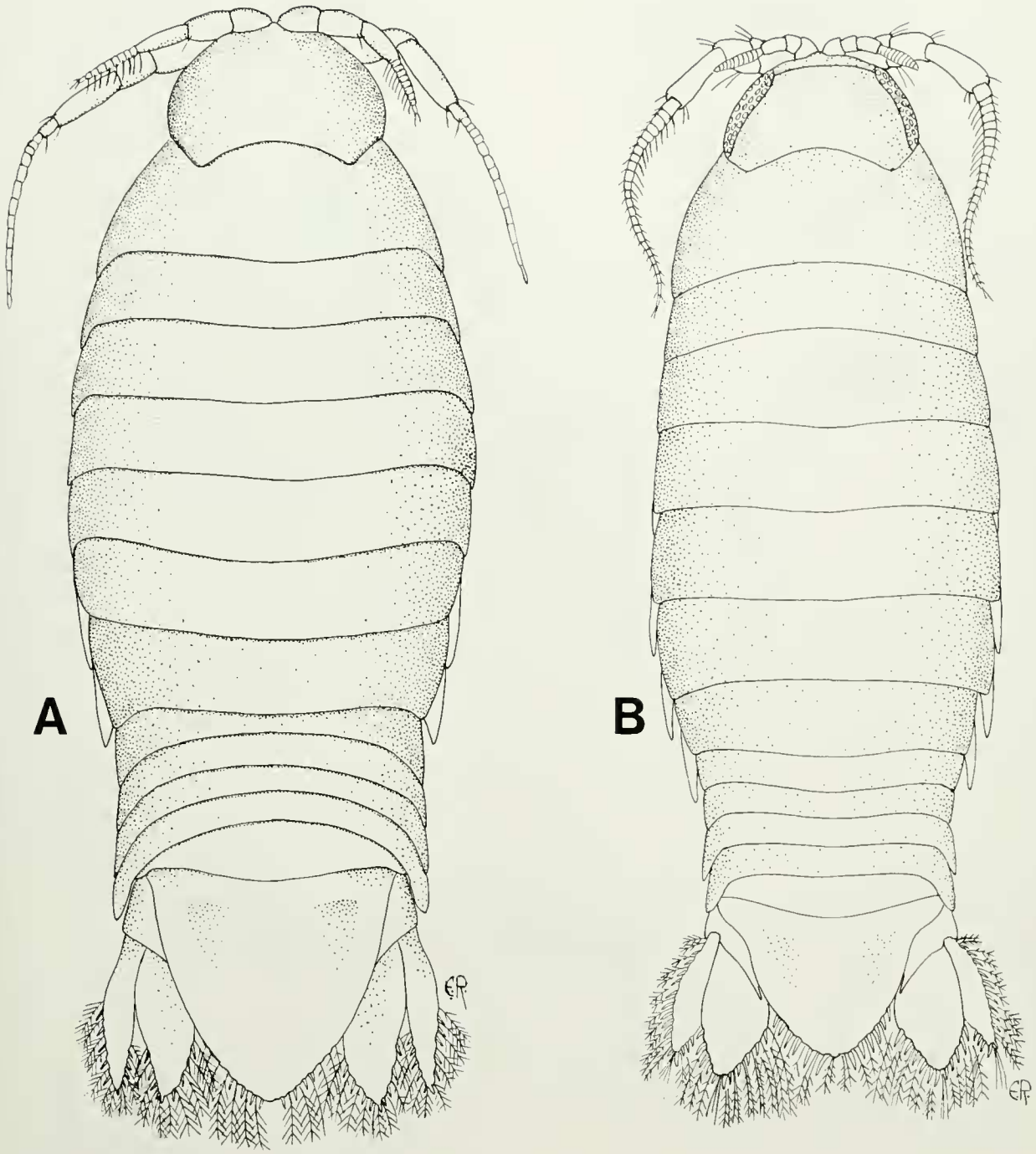

Figure 65. *Natatolana* of the tropical eastern Pacific, dorsal views: A, *N. californiensis* (AHF 6048), holotype, male. B, *N. carlenae* n. sp. (USNM 252731), holotype, male.

1. *N. albicaudata* (Stebbing, 1900). Australia, Philippines, and Japan.
2. *N. amplocula* Bruce, 1986. Kai Islands and the Arafura Sea, Indonesia.
3. *N. angula* Bruce, 1986. Queensland, Australia.
4. *N. anopthalma* (Kussakin and Vasina, 1982). Kerguelen Islands, Indian Ocean.
5. *N. arcicauda* (Holdich, Harrison, and Bruce, 1981). Queensland, Australia.
6. *N. arrama* Bruce, 1986. Victoria, Australia.
7. *N. boko* Bruce, 1986. Queensland, Australia.
8. *N. borealis* (Lilljeborg, 1851). Europe and South Africa.

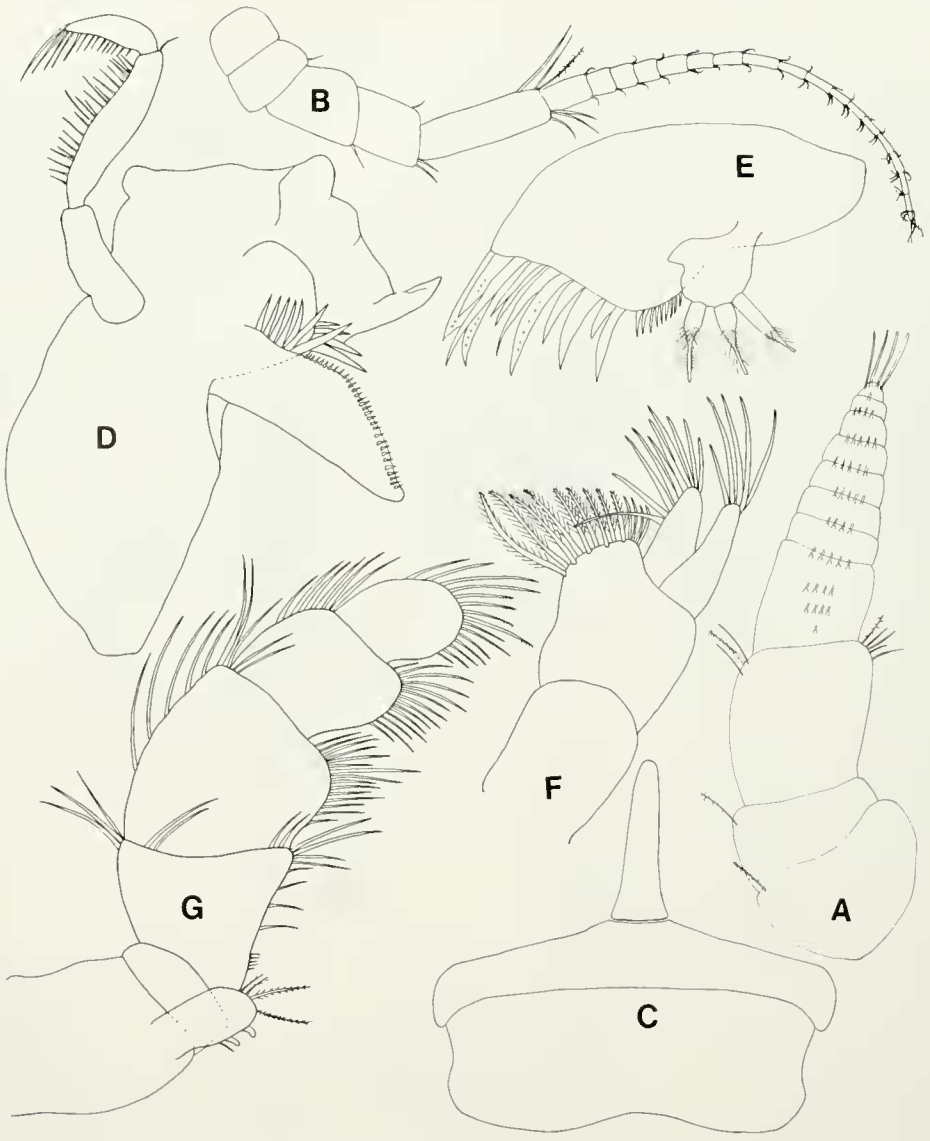

Figure 66. *Natatolana californiensis* (AHF 6048), holotype, male: A, antennule (left), only proximal region of aethetascs shown. B, antenna (left). C, frontal lamina, clypeus, and labrum. D, mandible (left). E, maxillule (left). F, maxilla (left). G, maxilliped (left).

9. *N. bowmani* Bruce, 1986. New South Wales, Australia.
10. *N. bulba* Bruce, 1986. Queensland, Australia.
11. *N. caeca* (Dollfus, 1903). Europe.
12. *N. californiensis* (Schultz, 1966). California to Gulf of California.
13. *N. carlenae* n. sp. Pacific Mexico to Panama.
14. *N. chilensis* (Menzies, 1962). Chile.
15. *N. corpulenta* (Hale, 1925). South Australia.
16. *N. curta* (Richardson, 1910). Philippines.
17. *N. endota* Bruce, 1986. New South Wales, Australia.
18. *N. galathea* Bruce, 1986. Gulf of Carpenteria, Australia.
19. *N. gallica* (Hansen, 1905). Atlantic coast of Europe.
20. *N. gorung* Bruce, 1986. Victoria, Australia.
21. *N. gracilis* (Hansen, 1890). West Indies to Brazil.
22. *N. hirtipes* (Milne Edwards, 1840). South Africa.
23. *N. insignis* Hobbins and Jones, 1993. Red Sea.
24. *N. intermedia* (Vanhöffen, 1914). Antarctica.
25. *N. japonensis* (Richardson, 1904). Japan.
26. *N. kahiba* Bruce, 1986. New South Wales, Australia.
27. *N. karkarook* Bruce, 1986. Queensland, Australia.
28. *N. laewilla* Bruce, 1986. New South Wales, Australia.
29. *N. longispina* Bruce, 1986. Victoria, Australia.
30. *N. lurur* Bruce, 1986. Western Australia.
31. *N. luticola* (Holdich, Harrison, and Bruce, 1981). Queensland, Australia.
32. *N. matong* Bruce, 1986. Tasmania, Australia.
33. *N. meridionalis* (Hodgson, 1910). Antarctica. [Bruce (1986a) synonymized *N. albinota* (Vanhöffen, 1914) with *N. meridionalis*; Brandt (1988) apparently was unaware of this synonymy].

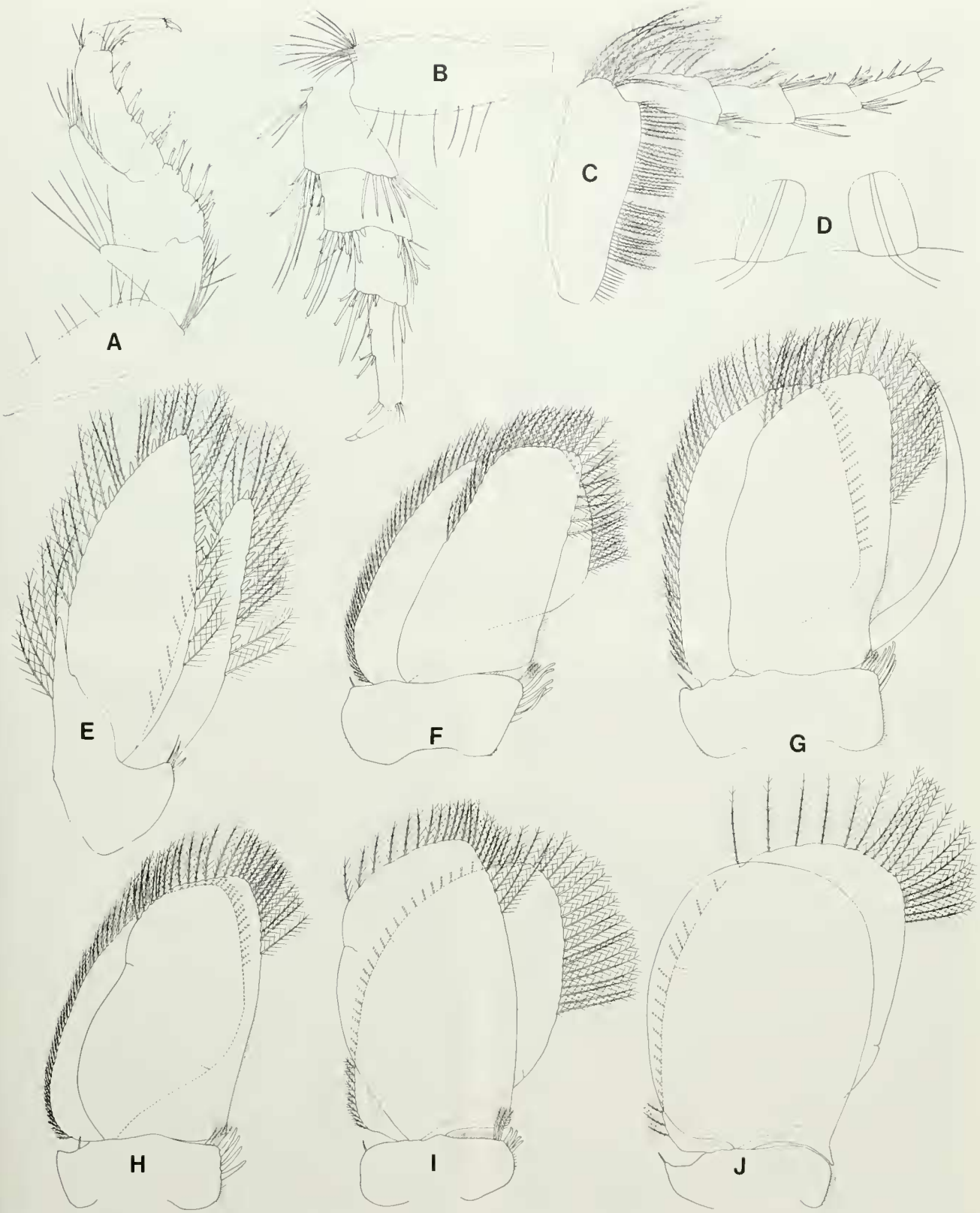

Figure 67. *Natatolana californiensis* (AHF 6048), holotype, male: A, pereopod I (left). B, pereopod IV (left). C, pereopod VII (left). D, penes. E, dorsal view of uropod (left). F, pleopod 1 (left). G, pleopod 2 (left). H, pleopod 3 (left). I, pleopod 4 (left). J, pleopod 5 (left).

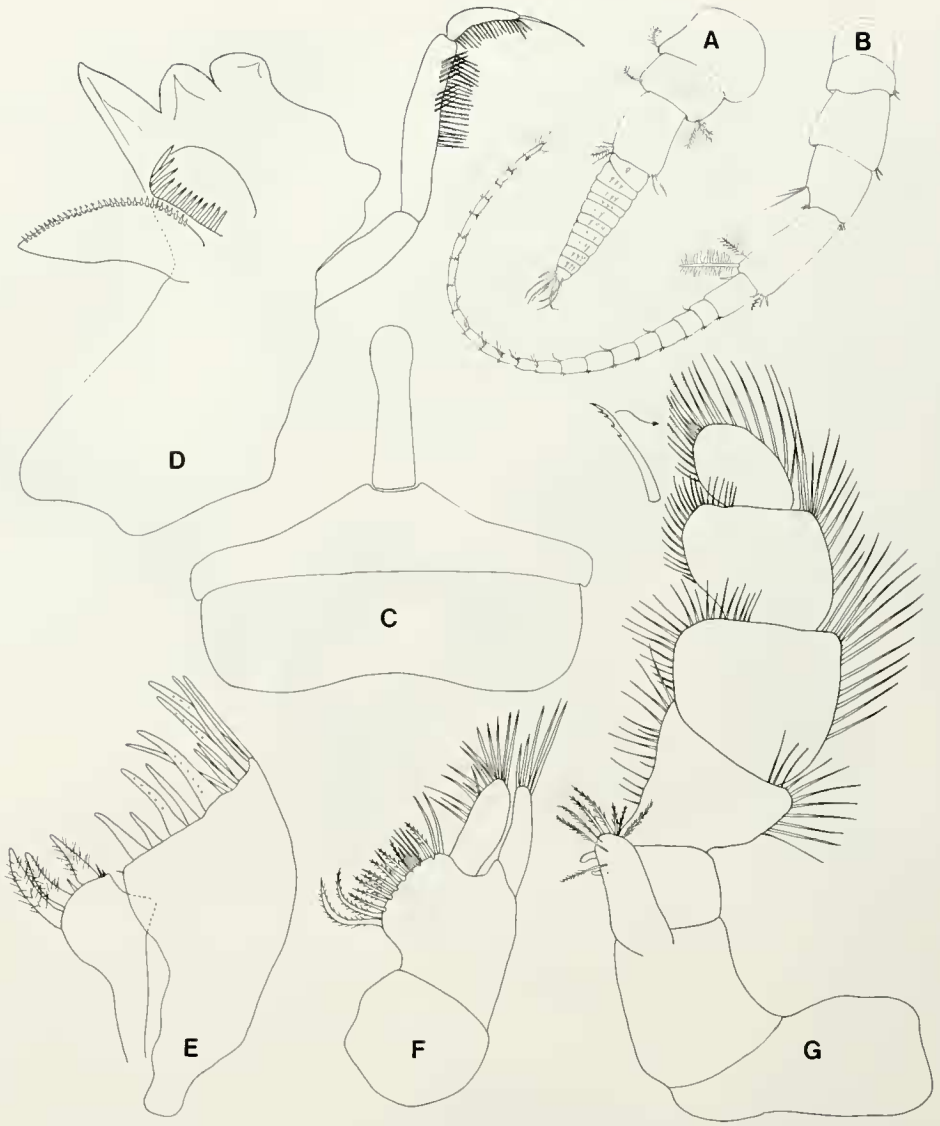

Figure 68. *Natatolana carlenae* n. sp. (USNM 252731), holotype, male: A, antennule (right), only proximal region of aethetascs shown. B, antenna (right). C, frontal lamina, clypeus, and labrum. D, mandible (right). E, maxillule (right). F, maxilla (right). G, maxilliped (right).

34. *N. nammuldi* Bruce, 1986. Victoria, Australia.
35. *N. narica* (Bowman, 1971). New Zealand.
36. *N. natalensis* (Barnard, 1940). South Africa.
37. *N. natalis* (Menzies and George, 1972). Peru.
38. *N. neglecta* (Hansen, 1890). Mediterranean.
39. *N. nitida* (Hale, 1952). Kerguelen and Crozet Islands, Indian Ocean.
40. *N. obtusata* (Vanhöffen, 1914). Antarctica.
41. *N. oculata* (Vanhöffen, 1914). Antarctica.
42. *N. pallidocula* (Kussakin and Vasina, 1982). Kerguelen Islands, Indian Ocean.
43. *N. pastorei* (Giambiagi, 1925). Tierra del Fuego.
44. *N. pellucida* (Tattersall, 1921). New Zealand and Australia.
45. *N. pilula* (Barnard, 1955). South Africa.
46. *N. prolixa* Bruce, 1986. Queensland, Australia.
47. *N. rossi* (Miers, 1876). New Zealand.
48. *N. schmidti* (Hansen, 1905). Faroes, northeast Atlantic.
49. *N. tenuistylis* (Miers, 1884). Australia.
50. *N. thalme* Bruce, 1986. Queensland, Australia.
51. *N. thurar* Bruce, 1986. Bass Strait, Australia.
52. *N. valida* (Hale, 1940). Bass Strait, Australia.
53. *N. variguberna* (Holdich, Harrison, and Bruce, 1981). Australia.
54. *N. vieta* (Hale, 1925). South Australia.
55. *N. virilis* (Barnard, 1940). South Africa.
56. *N. woodjonesi* (Hale, 1924). South Australia.
57. *N. wowine* Bruce, 1986. Victoria, Australia.
58. *N. wullunya* Bruce, 1986. New South Wales, Australia.

Key to Tropical Eastern Pacific *Natatolana* Species

1. Without eyes; pleotelson with 6–10 apical spines; mandibular palp with simple setae only; appendix masculina broadly curving, basally wide ..... *Natatolana californiensis*

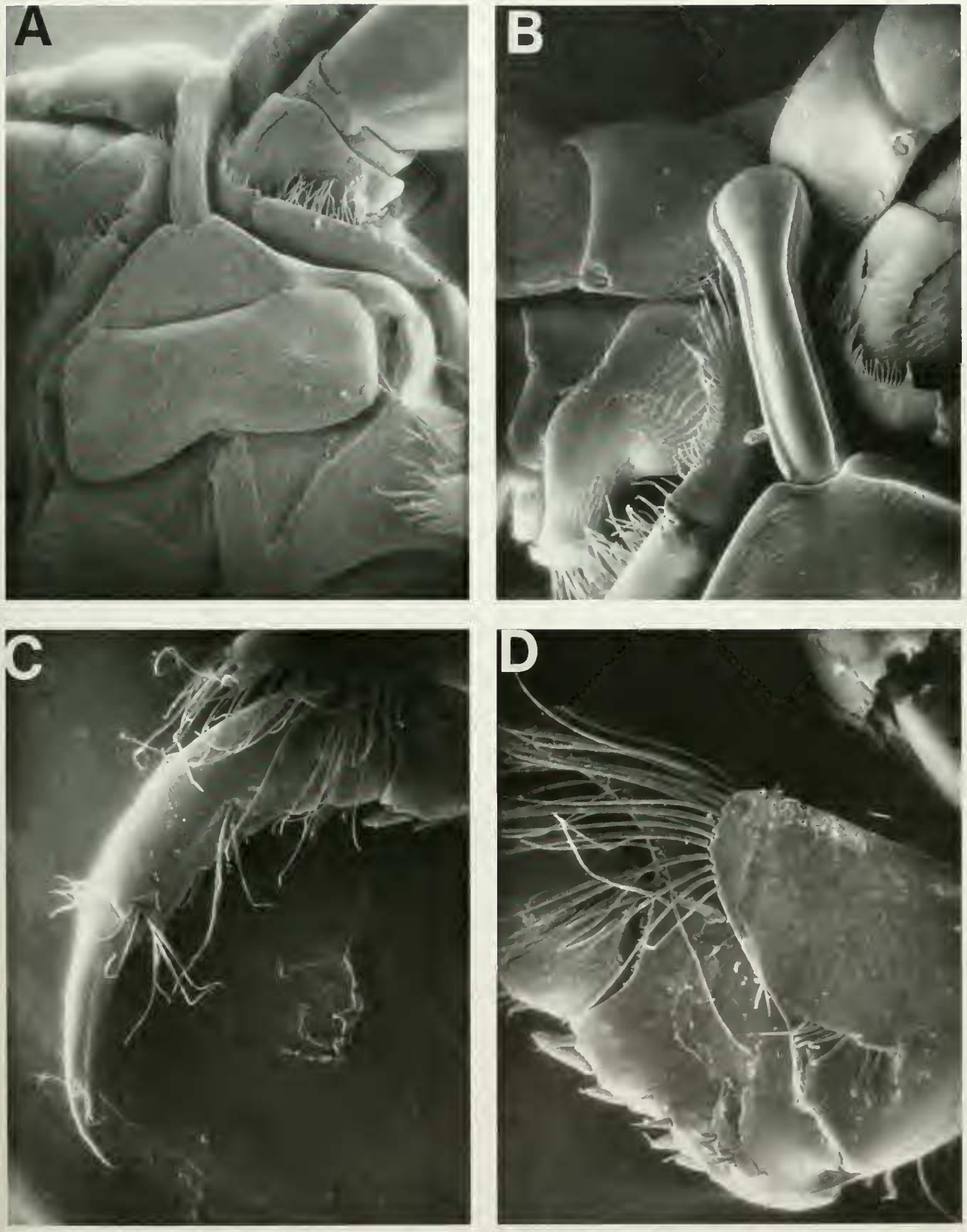

Figure 69. *Natatolana carlenae* n. sp. (AHF 959-1), scanning electron micrographs: A, frontal lamina, clypeus, and labrum, 40×. B, frontal lamina, 80×. C, pereopod I, dactylus, 40×. D, pereopod I, merus and carpus, 80×.

— With eyes (sometimes unpigmented but always with distinct ommatidia); pleotelson with 10–13 apical spines; mandibular palp with simple and comb setae; appendix masculina sublinear ..... *N. carlenae* n. sp.

Natatolana californiensis (Schultz, 1966)
Figs. 65A, 66, 67

Natatolana californiensis Bruce 1981a: 58; 1986a: 222. Brusca 1980: 228. Brusca and Iverson 1985: 37.

Ciralana californiensis Schultz 1966: 14; 1969: 178. Brusca and Ninos 1978: 379.

Cirolana deminuta Menzies and George 1972: 9. (Not *Ciralana diminuta* of Menzies, 1962b, and other authors).

Type material examined.—(1) Male holotype (LACM 60.88.4, AHF Type No. 6048): U.S.A., California, San Diego Co., Coronado Canyon, 32° 30.70' N, 117° 21.62' W, on green mud, 794 m; R/V *Velero IV* Sta. 6851-60; 1 Feb. 1960. (2) Paratypes (LACM 60.76.3, AHF Cat. No. 952-1): U.S.A., California, Los Angeles Co., San Clemente Island, Tanner Canyon, 54.8 mi., 250° T from China Point Light, 32° 37.87' N, 118° 58.70' W, 792 m; R/V *Velero IV* Sta. 6833-60; 29 Jan. 1960; 2 specimens.

Other material examined.—California specimens: (3) Santa Catalina Island, 6.75 mi. 92° T from Long Point Light; 33°24' N, 118° 13' W; R/V *Velero IV* Sta. 2228-53, AHF Cat. No. 752-1; 28 Feb. 1953; 1 male and 1 juvenile. (4) Santa Catalina Island, 33° 22' 30" N, 118° 36' 38" W, Campbell grab on sandy gray-green mud; R/V *Velero IV* Sta. 2847-54; 23 June 1954; 1 specimen. (5) San Clemente Island; R/V *Velero IV* Sta. 6351-59, AHF Cat. No. 933-1, LACM; 2 specimens. (6) San Clemente Island, 30.5 mi. 62° T to China Point; Sta. 24607-76, AHF Cat. No. 774-01, LACM; 1 male. (7) San Clemente Island, 63° T to China Point, 2–30 m; Sta. 24606, AHF Cat. No. 772-01, LACM; 2 mancas. (8) San Clemente Island, 29.7 mi. 66° T to China Point; AHF Cat. No. 773-01, LACM; 1 male. (9) No exact locality, 900–1250 m; SDNHM; 28 Aug. 1978; R/V *Calafia*, Calif. Dept. Fish and Game, coll. P. Gregory; 12 specimens.

Gulf of California specimen: (10) Angel de la Guarda Island, 7 mi. 253° T from south end, 1135–1138 m; R/V *Velero IV* Sta. 11827-67, LACM; 1 Dec. 1967; 1 nonovigerous female.

Description of male.—Cephalon width 1.8 times length. Eyes absent (Fig. 65A). Antennules extend barely to posterior region of cephalon; flagellum of 8–12 free articles, basal articles fused, each article with 1–5 long unjointed aesthetases (only the most basal portion of aesthetases figured) (Fig. 66A). Antenna reaching middle of pereonite II; flagellum of 10–22 articles (Fig. 66B). Frontal lamina not expanded anteriorly, narrowing and rounded (Fig. 66C). Mandibular spine row with about 11–14 stout spines; 2 lateral (outer) cusps of incisor weakly developed; middle and distal articles of palp with simple setae only (Fig. 66D). Maxillule's medial lobe with lateral protuberance, deep notch, and 3 stout strongly tapering circumplumose spines; lateral lobe with about 12 large spines, the largest with barbs, followed by 9 small subapical marginal spines (Fig. 66E). Maxilla medial lobe with 9 plumose setae and 4 simple setae; lateral lobes with 11 and 5 simple setae, respectively (Fig. 66F). Left maxillipedal endite with 2 or 3 coupling spines, right maxillipedal endite with 1 or 2 coupling spines and 2 apical and 2 subapical plumose setae; palp articles with simple marginal setae, most distal article also with comb setae as figured (Fig. 66G).

Pereon widest at pereonites IV and V. Coxae IV–VII produced beyond posterior margins of their segments; most posterior coxae visible in dorsal aspect (Fig. 65A). Pereopod I: inferior margin of ischium with long setae but no spines; inferior margins of merus, carpus, and propodus with stout spines as figured; superior lobe of ischium forms spoonlike depression into which merus collapses; carpus short (Fig. 67A). Pereopod IV not much longer pereopod I; distal superior margins of ischium and merus not produced; articles with setae and stout simple spines as figured (Fig. 67B). Pereopod VII not much longer than pereopod IV; basis and ischium with long plumose setae as figured; basis 2.5 times longer than wide; ischium, merus, carpus, and propodus with spines and simple setae as figured (Fig. 46C). Pereonite VII with small penile lobes (Fig. 67D).

Pleopodal rami with PMS as figured (Figs. 67F–J). Pleopod 1: peduncle's medial margin with 5 coupling spines and 3 plumose setae; lateral margin with 1 small spine; endopod 0.78 times width of exopod (Fig. 67F). Pleopod 2: peduncle's medial margin with 5 coupling spines and 3 plumose setae, lateral margin with 1 small spine; endopod 0.88 times width of exopod; appendix masculina scythelike, narrowing from base to apex, length 1.15 times exopod length (Fig. 67G). Pleopod 3: peduncle's medial margin with 4 coupling spines and 4 plumose setae, lateral margin with 1 short spine; endopod 0.95 times as wide as exopod, with short incision on lateral margin; exopod with short incision on medial margin (Fig. 67H). Pleopod 4: peduncle's medial margin with 4 coupling spines and 3 plumose setae, lateral margin with 1 spine; endopod 0.95 times as wide as exopod, with short incision on lateral margin; exopod with short incisions on medial and lateral margins (Fig. 67I). Pleopod 5: peduncle with 1 short spine on lateral margin, endopod width subequal to exopod width; exopod with short incisions on medial and lateral margins (Fig. 67J).

Pleotelson subtriangular, lateral margins slightly convex (not straight); distal quarter of pleotelson with marginal serrations and 6–10 spines interspersed with long PMS; dorsum with shallow paired submedian depressions near base (Fig. 65A). Uropods extend barely beyond apex of pleotelson, narrowed apically; rami without apical notches, margins slightly serrate, fringed with long PMS and short spines. Uropodal exopod 0.5 width of endopod; medial margin of exopod with 2–4 stout spines, lateral margin with 5–8 stout spines. Uropodal endopod with 4–6 stout spines on medial margin, 3–4 spines on lateral margin. Uropodal peduncle's inner angle with distal PMS; distolateral angle with 3 long spines (Fig. 67E).

Female.—Similar to male. Females not bearing oostegites have variously developed maxillipedal epipods.

Size —To maximum length of 13.4 mm.

Distribution.—Natatolana californiensis is primarily a southern California animal; we have examined a single specimen from the Gulf of California. Collection depths range from 792 to 1250 m.

Remarks.—The holotype is a male, not a female as reported by Schultz (1966: 15). Our description is based on the holotype and other California material. The single specimen from the Gulf of California differs from the California specimens in one regard only: the clypeus is notched anteriorly, below the posterior tip of the frontal lamina. Depth data for several of the *Velero IV* collection stations could not be found.

Natatolana carlenae n. sp.
Figs. 65B, 68-70

Type material examined.—(1) Male holotype (USNM 252731) and 5 male and female paratypes (USNM 252732): Mexico, Sonora (Gulf of California), Tiburon Island, on muddy sand, 73–101 m; Sta. No. 563-36, USNM Acc. No. 139772; 10 Mar. 1936.

Additional paratypes, Pacific Baja California specimens: (2) Cedros Island, 28° 04' N, 115° 20' W, 29 m; R/V *Velero IV* Sta. 1703-49, LACM; 5 Mar. 1949; 6 specimens. (3) 2 mi. S.E. of Cedros Island Light; 28° 20' N, 115° 10' W, 101 m; R/V *Velero III* Sta. 1265-41, LACM; 28 Feb. 1941; 5 specimens. (4) Dewey Channel, San Eugenio Point, 27° 49' 32" N, 115° 06'15" W; R/V *Velero III* Sta. 1260-41, LACM; 27 Feb. 1941; 1 male. (5) Thurloe Head, 27° 34' N, 114° 50' W, 70 m; R/V *Velero IV* Sta. 11841-67, LACM; 7 Dec. 1967; 1 male and 1 female.

Figure 70. *Natatolana carlenae* n. sp. (USNM 252731), holotype, male: A, pereopod I (right). B, pereopod IV (right). C, pereopod VII (right). D, uropod (right). E, pleopod 1 (right). F, pleopod 2 (right). G, pleopod 3 (right). H, pleopod 4 (right). I, pleopod 5 (right).

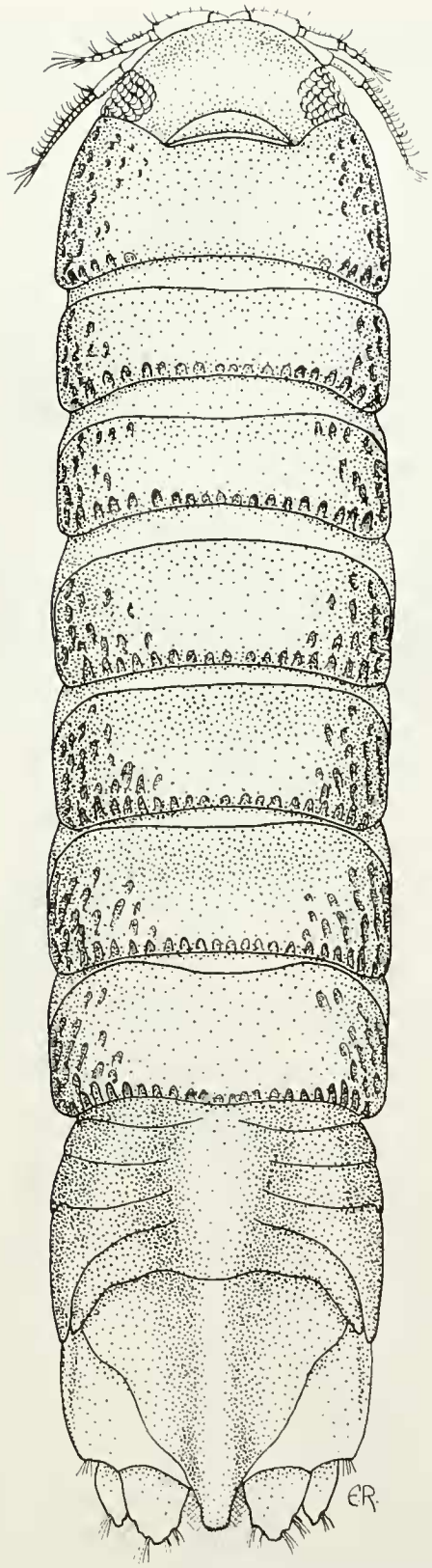

Figure 71. *Oncilorpheus jerrybarnardi* n. sp. (LACM 39-51.17, AHF Cat. No. 896-04), holotype, male.

Gulf of California specimens (all Baja California): (6) North of Angel de la Guarda Island, 73–128 m; R/V *Velero III* Sta. 546-36, USNM Acc. No. 139772; 5 Mar. 1936; 2 specimens. (7) North of Angel de la Guarda Island, 15–18 m; R/V *Velero III* Sta No. 551-36, USNM Acc. No. 139772; 1 specimen. (8) Angel de la Guarda Island, Puerto Refugio, 165 m; R/V *Velero III* Sta. 709-37, USNM Acc. No. 144492; 21 Mar. 1937; 3 specimens. (9) Angel de la Guarda Island, Puerto Refugio, on sand, 119 m; R/V *Velero III* Sta. 544-36, USNM Acc. No. 139772; 4 Mar. 1936; 4 specimens. (10) Angel de la Guarda Island, Puerto Refugio, with oysters, 28–55 m; R/V *Velero III* Sta. No. 542-36, USNM Acc. No. 139772; 4 Mar. 1936; 1 specimen. (11) Los Angeles Bay, on sand, 46–73 m; R/V *Velero III* Sta. 535-36, USNM Acc. No. 139772; 2 Mar. 1936; 1 specimen. (12) Los Angeles Bay, 33 m; R/V *Velero III* Sta. 702-37, USNM Acc. No. 144492; 20 Mar. 1937; 2 specimens. (13) Los Angeles Bay, 59 m; R/V *Velero III* Sta. 701-37, USNM Acc. No. 144492; 20 Mar. 1937; 3 specimens. (14) North of Coyote Point, 25° 49' N, 111° 11' W, dredge, sand, mud, and shell, 51 m; R/V *Velero IV* Sta. 1753-49, LACM; 20 Mar. 1949; 2 specimens. (15) Between Cerralvo Island and La Paz, benthic trawl, 247 m; Sta. 3, AHF Cat. No. 959-1, LACM; 7 Sept. 1969; coll. R. Schaffer; 4 specimens. (16) Ensenada de los Muertos, with shell fragments, 73 m; R/V *Velero III* Sta. 629-37, USNM Acc. No. 144492; 5 Mar. 1937; 1 specimen.

Central Eastern Pacific specimens: (17) Costa Rica, Port Parker; 10° 57' N, 85° 49' W, sandy mud, 9–18 m; R/V *Velero III* Sta. 936-39, LACM; 25 Mar. 1939; 2 specimens. (18) Panama, Secas Island, mud and shells, 46 m; USNM Acc. No. 128938; 22 Feb. 1934; 1 male, damaged, probably dried and rehydrated.

Description of male.—Cephalon width 1.9 times length. Eyes elongate, well-developed (Fig. 65B), unpigmented or golden (in ethanol), visible in ventral aspect. Antennular peduncle articles with simple and palmate setae; flagellum of 10 or 11 articles, each article with 1–3 long unjointed aesthetascs (only most basal portions of aesthetascs figured) (Fig. 68A). Antenna reaching pereonite III; flagellum of 23 to 24 articles, with simple and palmate setae as figured (Fig. 68B). Frontal lamina with anterior margin expanded and rounded (Fig. 68C, 69A, B). Mandibular spine row with about 13 stout spines; inner and middle cusps of incisor acute, outer cusp rounded, all 3 cusps with elevated ridges; middle and distal palp articles with simple and comb setae, apical seta of distal article very long as figured (Fig. 68D). Maxillule's medial lobe with lateral protuberance, 3 stout circumplumose spines, and 3 small simple spines; lateral lobe with about 12 large spines, largest spines with barbs (Fig. 68E). Maxilla's medial lobe with about 11 plumose and 8 simple setae; lateral lobes with 15 and 5 simple setae, respectively (Fig. 68F). Left and right maxillipedal endites short, each with 2 coupling spines and plumose setae; palp articles with simple setae, most distal article also with comb setae (Fig. 68G).

Pereon widest at pereonites IV and V. Coxae IV–VII visible in dorsal view, produced well beyond the posterior margins of their respective pereonites; coxa VII produced almost to posterior margin of pleonite 2 (Fig. 65B). Pereopod I: merus, carpus, and propodus with stout spines as figured; lobe of ischium and merus with very large distal spines; lobe of ischium forms distal spoonlike depression into which merus collapses; carpus very short (Figs. 69C, D, 70A). Pereopod IV with distal margins of ischium and merus not produced as on pereopod I; inferior margins of articles with very long simple setae and spines as figured (Fig. 70B). Pereopod VII long, very setose; basis 1.6 times longer than wide; ischium with simple and plumose setae, simple spines, and about 6 serrate spines; merus and carpus with simple setae and simple and serrate spines (Fig. 70C). Pereonite VII without penes.

Pleopodal rami with PMS as figured; all pleopodal peduncles with 1 lateral spine and cluster of sublateral simple setae (Figs. 70E–I). Pleopod 1: peduncle's medial margin with 5 coupling spines and 4 plumose setae; 1 spine near lateral margin; endopod width 0.66 times width of exopod (Fig. 70E). Pleopod 2: peduncle's

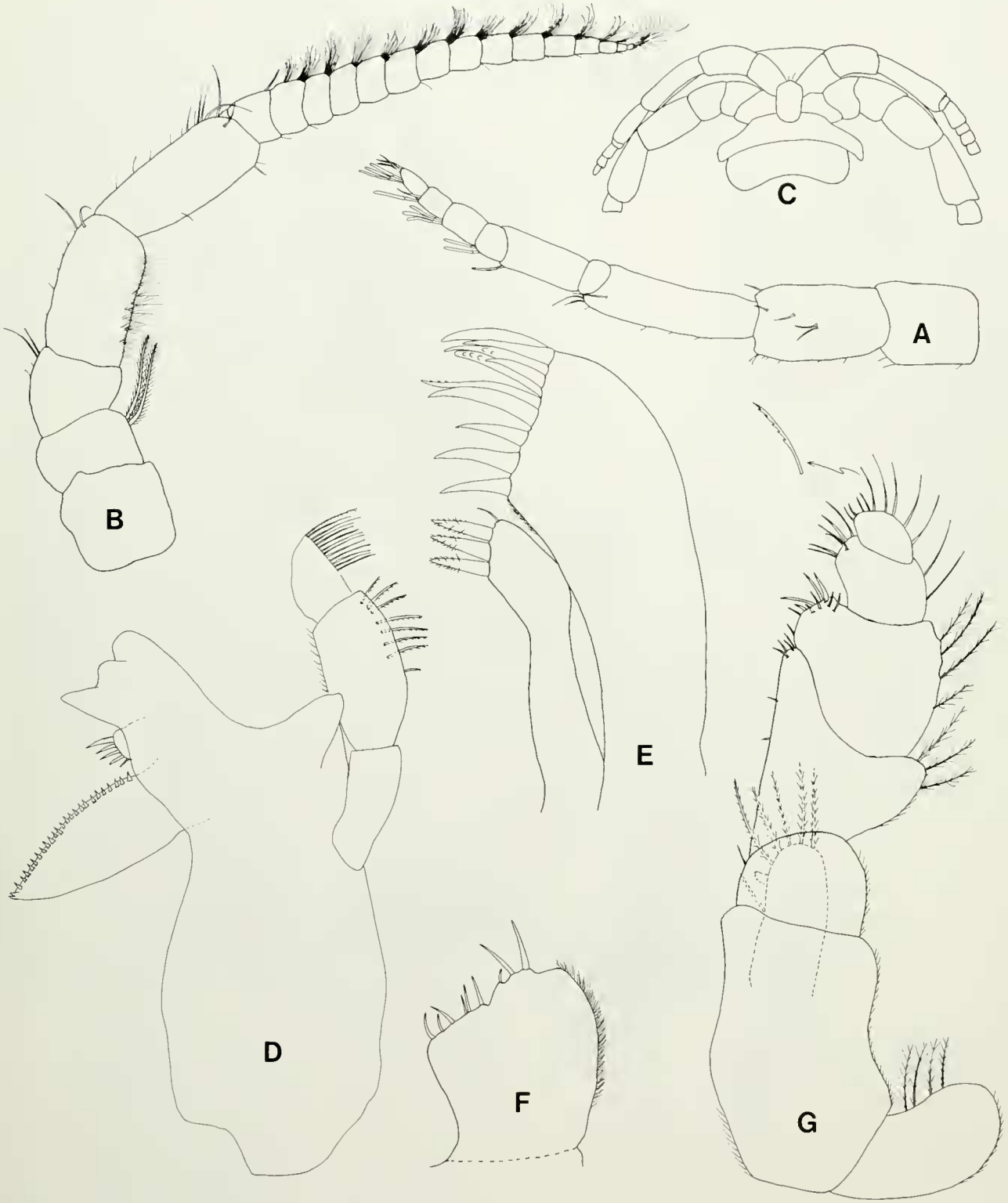

Figure 72. *Oncilorpheus jerrybarnardi* n. sp. (LACM 39-51.17, AHF Cat. No. 896-04): A, antennule (right). B, antenna (right). C, frontal lamina, clypeus, and labrum. D, mandible (left). E, maxillule (left). F, maxilla (left). G, maxilliped (left).

medial margin with 4 coupling spines and 5 plumose setae; endopod width 0.98 times width of exopod; appendix masculina simple; length 0.97 times endopod length (Fig. 70F). Pleopod 3: peduncle's medial margin with 4 coupling spines and 7 plumose setae; endopod subequal to exopod in width, with short incision on lateral margin; exopod with short incision on medial margin (Fig. 70G). Pleopod 4: peduncle's medial margin with 5 coupling spines and 7 plumose setae; endopod subequal to exopod in width, with short incisions on medial and lateral margins; exopod with short incision on medial margin (Fig. 70H). Pleopod 5: peduncle somewhat irregularly

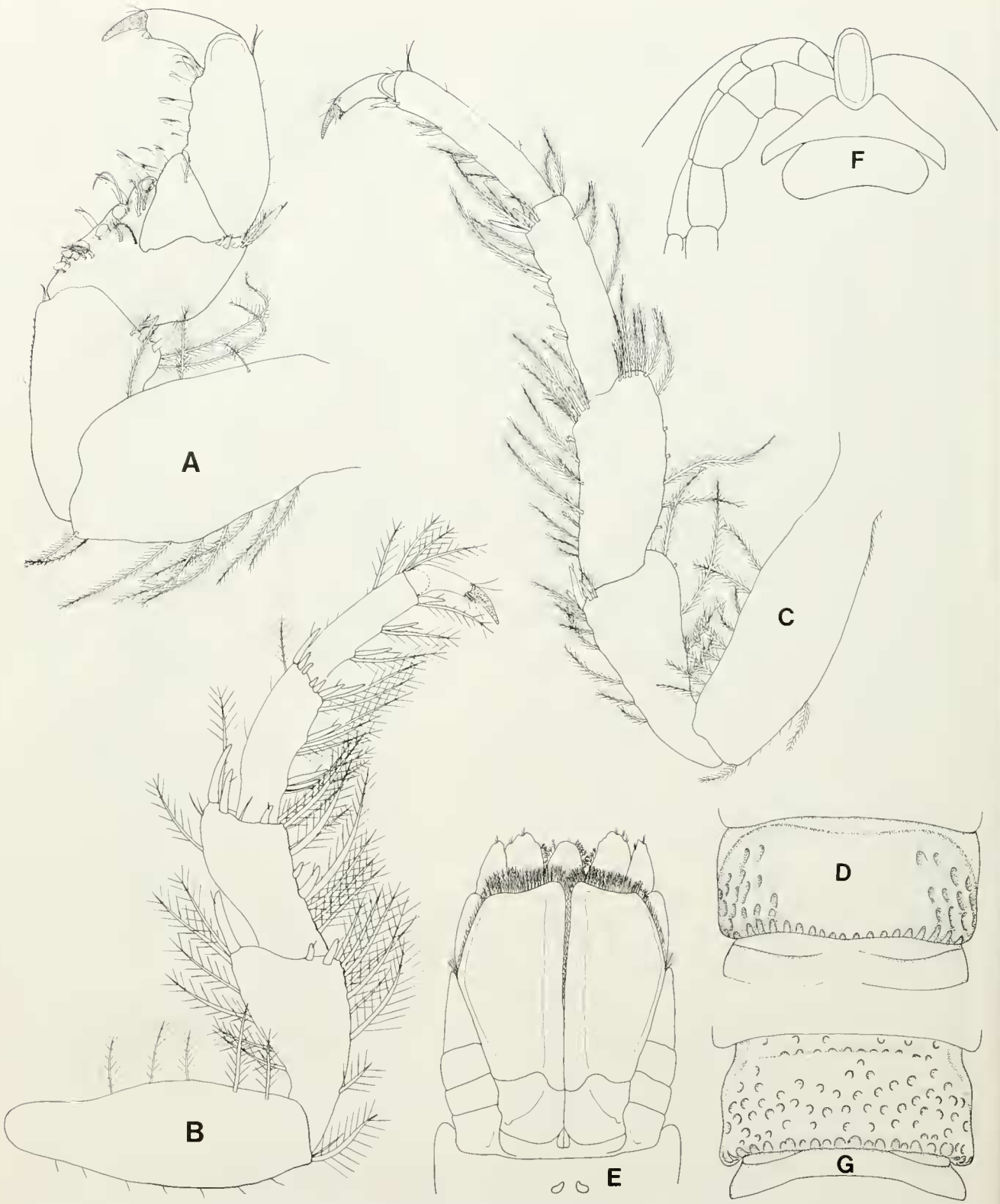

Figure 73. *Oncilorpheus jerrybarnardi* n. sp. (LACM 39-51.17, AHF Cat. No. 896-04): A, pereopod I (left). B, pereopod IV (left). C, pereopod VII (left). D, dorsal view of pereonite III. E, ventral view of penes on sternite VII, and pleopod 1. *Oncilorpheus stebbingi* (holotype): F, frontal lamina, clypeus and labrum. G, dorsal view of pereonite III.

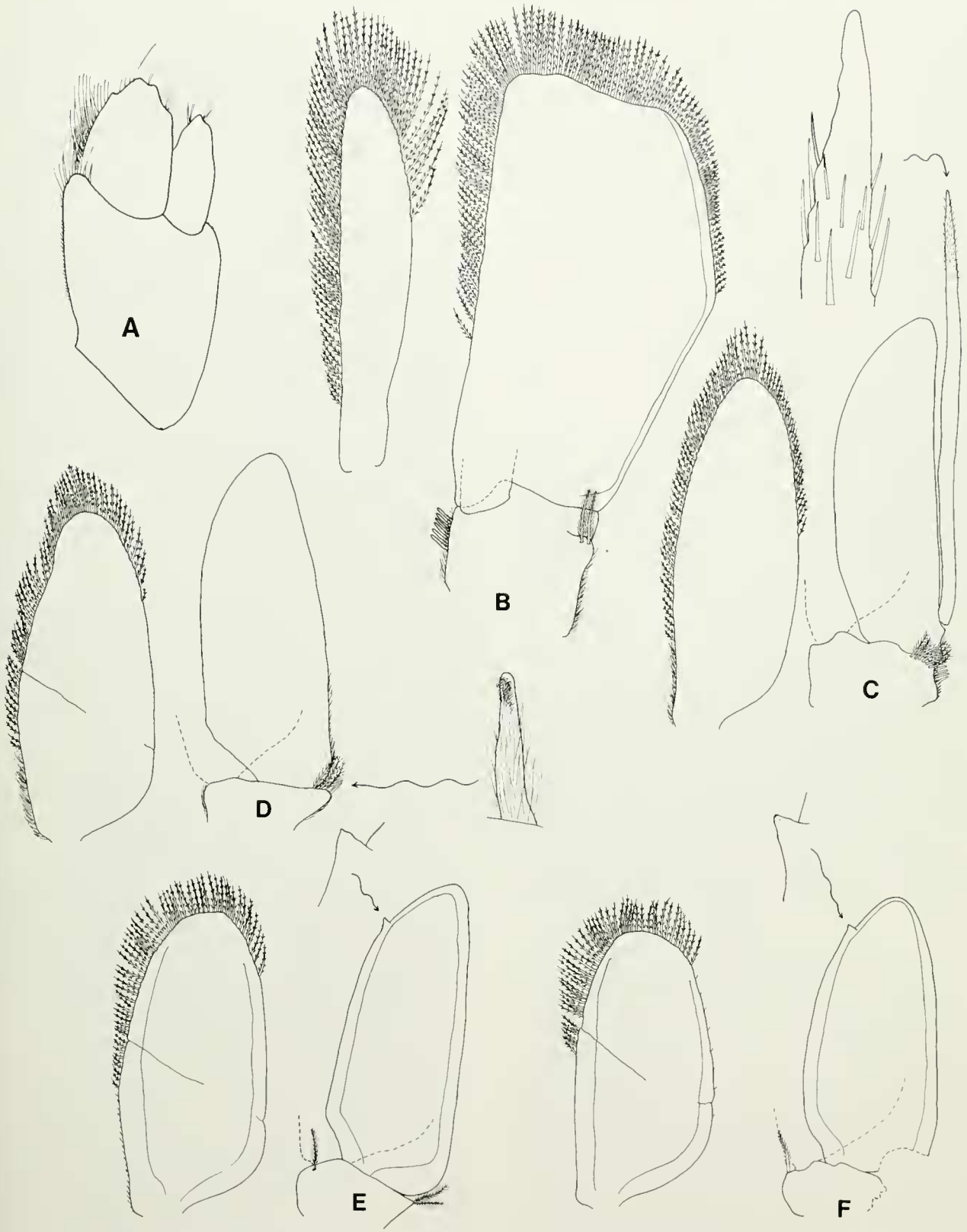

Figure 74. *Oncilorpheus jerrybarnardi* n. sp. A, uropod (left) from paratype, female (USNM 252738). B–F, pleopods (left) from holotype, male (LACM 39-51.17, AHF Cat. No. 896-04): B, pleopod 1. C, pleopod 2. D, pleopod 3. E, pleopod 4. F, pleopod 5.

shaped, lateral margin produced into elongate lobe; endopod subequal to exopod in width; proximolateral angle of exopod slightly produced, rounded, lobelike (Fig. 70I).

Pleotelson subtriangular, lateral margins slightly convex (not straight); distal quarter of pleotelson with marginal serrations, PMS, and 10–14 stout spines; dorsum devoid of tubercles or carinae, but with a pair of shallow submedian depressions near base. Uropods extend beyond apex of pleotelson, margins slightly serrate, fringed with long PMS and stout spines, narrowed apically, without apical notches on rami (Fig. 65B). Uropodal exopod 0.58 times width of endopod; medial margin of exopod with about 3 spines, lateral margin with 7–9 spines. Uropodal endopod with 4–7 spines on medial margin, spines on lateral margin, and a single apical spine. Uropodal peduncle inner angle with PMS; dorsal surface of lateral (outer) angle with 3 stout spines and PMS as figured (Fig. 70D).

Female. — Similar to male.

Ultrastructural Features.—When viewed with an SEM, most of the body and appendages show a scalelike cuticular structure. The dorsal regions of the antennules, antennae, and body have minute cuticular sensillae (Figs. 69A, B).

Size.—To maximum length of 16.8 mm.

Distribution.—Known from northwestern Baja California (Pacific), the Gulf of California, Costa Rica, and Panama, at depths ranging from 9 to 1168 m. Although the depth range of this species is remarkably broad, we have not observed any differences between shallow- and deep-water specimens. This species is generally found in waters shallower than is *N. californiensis*. Of 18 specimen lots with depth data, 16 were from depths of 9 to 165 m; and only 2 were from depths of 247 to 1168 m; most records are from depths of 25 to 170 m. Recorded substrates include sand, mud, and shell fragments; 1 specimen was found "with oysters." *Natatolana carlenae* appears to be fairly common in soft-bottom subtidal habitats, particularly in the Gulf of California.

Remarks.—This species is very similar to *Natatolana californiensis*. The main characters separating the two are the presence of eyes in *N. carlenae*, the number of apical pleotelson spines (10–14 in *N. carlenae*, 6–10 in *N. californiensis*), and uropod spination. Several small, barely postmanca specimens of *Natatolana carlenae* have definite pigmented eyes and 12 pleotelson spines, indicating that these are not age- or size-related variations but good species differences.

Etymology. — This common Gulf of California species is named for the senior author's daughter, Carlene, in appreciation of the many collecting trips she participated on in the Sea of Cortez, many before she was old enough to know what an isopod was.

Oncilorpheus Paul and Menzies, 1971

Type species.—*Oncilorpheus stebbingi* Paul and Menzies, 1971, by original designation. Type specimens at USNM.

Oncilorpheus Paul and Menzies 1971: 29. Kensley and Schotte 1989: 139.

Description.—Body elongate, 4.0–5.0 times longer than broad; dorsum of pereon with numerous pits or scalloped depressions. Eyes moderate in size. Cephalon lacking rostrum, moderately immersed in pereonite I; posterior region of cephalon with nearly complete incision line. Frontal lamina robust, projecting anteroventrally, 1.8–2.4 times longer than broad, apex subacute or rounded; clypeus flat (sessile), short, broad, wider than long; labrum narrower than clypeus. Antennular peduncle 3-articulate; second article not articulated at right angles to first article (as in *Eurydice*); peduncular basal articles generally longer than wide; article 3 longest. Antenna short, only slightly longer than antennule; peduncle 5-articulate; articles 4 and 5 subequal in length and longer than others. Mandible with tridentate incisor; palp 3-articulate, middle article longest; spine row a small tapered lobe with stout spines. Maxillule's medial lobe with 3 stout circumplumose spines; lateral lobe with about 10 stout spines. Maxilla reduced, short, a single lobe, apex with simple setae. Maxillipedal palp 5-articulate; endite small, with 1 or 2 coupling spines and plumose setae.

Pereopodal dactyli with short stout accessory spine at base of unguis; distal superior margin of ischium of pereopods I–III not greatly produced; distal superior margin of merus produced. Pereopods V–VII with basis not markedly flattened or enlarged; pereopod VII long and slender; ischium, merus, carpus, and propodus subequal in length, each one successively narrower. Penes well developed on sternite of pereonite VII.

Pleon of 5 somites, which may be fused medially; lateral margins of pleonite 5 largely encompassed by pleonite 4. Pleopod 1's exopod large, indurate, and operculate; endopods of pleopods 2–5 lack PMS. Pleopodal peduncles 2–5 barely wider than long, without accessory lobes; appendix masculina of male arises subbasally from medial margin of endopod of pleopod 2. Pleotelson tapering strongly posteriorly, apex subacute or bluntly rounded, never indented. Uropodal peduncles longer than rami; inner angle strongly produced, with bluntly rounded apex; exopod triangular, distally acute.

Remarks. — Several emendations to the original description of this genus (Paul and Menzies 1971) are necessary. In both *Oncilorpheus stebbingi* and *O. jerrybarnardi* n. sp., the cephalon is moderately immersed in pereonite I. Figure 2 of Paul and Menzies' paper fails to show this degree of immersion in *O. stebbingi*. The frontal lamina, clypeus, and labrum of *O. stebbingi* are refigured in our Figure 73F. Paul and Menzies did not describe the uniquely reduced maxillae of this genus; in both *O. stebbingi* and *O. jerrybarnardi* n. sp. the lateral and medial lobes are reduced to a single simple lobe (indicated by a faint cuticular ridge in *C. jerrybarnardi* n. sp.). Their Fig. 3C identifies this appendage as "the inner plate of the second maxilla." They also did not describe or figure the unique body sculpturing typical of the genus (Figs. 71, 73 D, G).

World list of species.—

1. *O. stebbingi* Paul and Menzies, 1971. Venezuela.
2. *O. jerrybarnardi* n. sp. Pacific Costa Rica and Panama.

Oncilorpheus jerrybarnardi n. sp.
Figs. 71–74

Type material examined.—(1) Male holotype (LACM 39-51.17): Panama (Pacific), Medidor Island, Honda Bay; R/V *Velero III* Sta. 948-39, AHF Cat. No. 896-04. Paratypes: (2) USNM 252737, Costa Rica (Pacific), Playa Blancas, along north point, with mud, sand, and algae, 28 m; R/V *Velero III* Sta. 461-35, USNM Acc. No. 131571; 8 Feb. 1935; 1 male. (3) LACM 39-48.8, Panama (Pacific), Secas Island, 50–52 m; R/V *Velero III* Sta. 945-39, AHF Cat. No. 2094; 1 female. (4) USNM 252738, Panama (Pacific), Secas Island; No. 458; 6 Feb. 1935; 3 specimens. (5) USNM 252739, Panama (Pacific), Secas Island, south of group, with mud and shells, 46 m; No. 250, USNM Acc. No. 128938; 22 Feb. 1934; 2 specimens.

Description of male.—Cephalon wider than long; frontal margin convex, evenly rounded. Eyes situated posterolaterally (Fig. 71). Antennule short, reaching posterior margin of cephalon; flagellum of 6–8 articles (Fig. 72A). Antenna reaching middle of pereonite I; flagellum of about 15 articles (Fig. 72B). Frontal lamina about 1.5 times as long as broad; apex forms blunt angle (Fig. Fig. 72C). Mandible with broad tridentate incisor; spine row with about 5 large stout spines; molar process with about 26 small acute spines; middle palp article with about 7 comb setae and 1 simple seta, distal article with about 14 simple and comb setae (Fig. 72D). Maxillule's

medial lobe with 3 circumplumose spines and 1 simple seta; lateral lobe with 10 stout spines, some armed with small apical barbs (Fig. 72E). Maxilla with about 9 simple apical setae and numerous fine lateral setae (Fig. 72F). Maxillipedal palp articles 2 and 3 with plumose setae on lateral margins; all articles with simple setae; left endite with 1 coupling spine, right endite with 2 coupling spines, each with 5 apical plumose setae (Fig. 72G).

Body very straight-sided; pereonite I longest, IV–VII subequal, longer than II and III; all pereonites subequal in width (Fig. 71). Coxae well developed but not projecting posteriorly beyond their respective pereonites; not visible in dorsal view. Pereonites heavily calcified, dorsum with numerous ridges and scalloped pits (Figs. 71, 73D). Pereopod I stout, with simple and plumose setae and spines as figured; inferior margin of merus with 6 distinct blunt molariform spines (Fig. 73A). Pereopod IV with carpus and propodus slender, slightly longer than merus, all articles with many plumose and simple setae and spines (Fig. 73B). Pereopod VII with carpus and propodus slender, longer than merus; all articles with many plumose and simple setae and spines as figured (Fig. 73C). Penes small, set close together in middle of sternite VII (Fig. 73G).

Pleon widest and longest at pleonite 4. Pleon with strong median dorsal carina, terminating at pleotelson apex. All pleonites (except occasionally 1) fused medially (Fig. 71). Pleopodal rami with PMS as figured (Figs. 74B–F). Exopod of pleopod 1 highly calcified, longer than endopod, 3.2 times wider than endopod, fringed with short, close-set PMS; endopod slender, 5 times longer than wide, fringed with short PMS; peduncle subquadrate, with 6 coupling spines on medial margin and 2 plumose setae near distolateral margin (Fig. 74B). Pleopod 2: peduncle's medial margin with 4 coupling spines and 6 plumose setae; exopod slightly longer and wider than endopod; appendix masculina with rounded spinose apex; length 1.26 times endopod length (Fig. 74C). Pleopod 3: peduncle with 2 coupling spines and 3 plumose setae on medial margin; exopod slightly wider than endopod, subequal in length, exopod with incomplete transverse incision (Fig. 74D). Pleopod 4: peduncle with 1 or 2 coupling spines and 2 plumose setae on medial margin and 1 plumose seta on lateral margin; exopod wider than endopod but subequal in length, exopod with incomplete transverse incision; acute protuberance on endopod subapical margin (Fig. 74E). Pleopod 5: peduncle without coupling spines, with 1 plumose setae on lateral margin; exopod subequal in length and width to endopod, with incomplete transverse incision; acute protuberance on endopod's subapical margin (Fig. 74F).

Pleotelson subtriangular, lateral margins sinuate, apex narrowly truncate. Uropodal peduncle broadly expanded, about twice as wide as endopod, apex of distal–medial angle bluntly rounded (Fig. 74A). Exopod half as wide as endopod; both endopod and exopod extend beyond pleotelson apex. Pleotelson and uropods with abundant marginal setae, but apparently lacking spines (Fig. 71).

Female.—Similar to male.

Size.—To a maximum length of 15 mm.

Distribution.—A subtidal species, found at depths of 28 to 52 m on mud, sand, and shell bottoms. So far known only from three localities in the Pacific: Medidor and Secas Islands, Panama, and Playas Blancas, Costa Rica.

Remarks.—Oncilorpheus stebbingi is known from only 3 specimens collected off Venezuela in the Atlantic (11° 57' N, 64° 37' W), at 73 m depth (Paul and Menzies 1971). This distribution suggests that the only two species of the genus may be vicariant descendants of the transisthmian "Tertiary Caribbean Province" described by Woodring (1957, 1966), Croizat et al. (1974), Rosen (1975), Brusca (1980), and others.

Oncilorpheus jerrybarnardi n. sp. differs from *O. stebbingi* by the convex frontal margin of the cephalon, the restriction of cuticular sculpturing to marginal regions of the pereonites, the middorsal longitudinal carina of the pleon, pleonites 2–5 being fused medially, and the sinuate lateral margins of the pleotelson.

Bruce (1986a) and Botosaneanu et al. (1986) placed *Oncilorpheus* in an informal genus-group closely corresponding to the "*Conilera*-group" of Monod (1930). Wetzer et al. (1987) recommended removal of *Oncilorpheus* from this group.

Etymology. — This species is named in memory of the great amphipod taxonomist J. Laurens Barnard, an inspiration, often a sage, and always a kind and gentle man. The patronym stands in appropriate company with the only other described species in this genus.

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LITERATURE CITED

Alheit, J., and E. Naylor. 1976. Behavioural basis of intertidal zonation of *Eurydice pulchra* Leach. Journal of Experimental Marine Biology and Ecology 23:135–144.

Bally, R. 1983. The respiration of the marine isopod *Excirolana natalensis* (Flabellifera; Cirolanidae) from an exposed sandy beach. Comparative Biochemistry and Physiology 75A(4):625–629.

Barnard, J. L., and G. S. Karaman. 1991. The families and genera of marine gammaridean Amphipoda (except marine gammaroids). Records of the Australian Museum, Supplement 13 (parts 1/2).

Barnard, K. H. 1914. Contributions to the crustacean fauna of South Africa. No. 3. Additions to the marine Isopoda, with notes on some previously incompletely known species. Annals of the South African Museum 10:325a–358a, 359–442.

———. 1920. Contributions to the crustacean fauna of South Africa. No. 6. Further additions to the list of marine Isopoda. Annals of the South African Museum 17:319–438.

———. 1935. Report on the Amphipoda, Isopoda and Tanaidacea in the collections of the Indian Museum. Records of the Indian Museum, Calcutta 37:279–319.

———. 1940. Contributions to the crustacean fauna of South Africa. No. 12. Further additions to the Tanaidacea, Isopoda and Amphipoda, together with keys for the identification of hitherto recorded marine and freshwater species. Annals of the South African Museum 32:381–515.

Bate, C. S., and J. O. Westwood. 1867. A History of British Sessile-Eyed Crustacea. Vol. 2, parts 16–19. John van Voorst, London.

Beneden, M. P.-J. van. 1861. Recherches sur les Crustacés du littorale de Belgique. Première partie. Mémoires de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique 33:1–174.

Biernbaum, C. K., and E. L. Wenner. 1993. Trapping of necrophagous crustaceans on the upper continental slope off South Carolina, U.S.A. Journal of Crustacean Biology 13:601–608.

Botosaneanu, L., N. L. Bruce, and J. Notenboom. 1986. Isopoda: Cirolanidae. Pp. 412–422 *in* L. Botosaneanu (ed.). Stygofauna Mundi. E. J. Brill, Leiden, Netherlands.

Bott, R. 1954. Ein neuer littoraler Isopod aus Peru. Senckenbergiana Biologica 35:107–108.

Bowman, T. E. 1977. Isopod crustaceans (except Anthuridae) collected on the Presidential Cruise of 1938. Proceedings of the Biological Society of Washington 89:653–666.

———, N. L. Bruce, and J. D. Standing. 1981. Recent introduction of the cirolanid isopod crustacean *Cirolana arcuata* into San Francisco Bay. Journal of Crustacean Biology 1:545–557.

———, and R. Franz. 1982. *Anopsilana crenata*, a new troglobitic cirolanid isopod from Grand Cayman Island, Caribbean Sea. Proceedings of the Biological Society of Washington 95:522–529.

———, and T. M. Iliffe. 1987. *Anopsilana lingua*, a new freshwater troglobitic isopod from the Palau Islands (Flabellifera: Cirolanidae). Proceedings of the Biological Society of Washington 100:347–352.

———, and ———. 1991. *Amnina fustis*, a new isopod from Phang Nga, Thailand (Crustacea: Isopoda: Cirolanidae). Proceedings of the Biological Society of Washington 104:247–252.

Brian, A., and E. Dartevelle. 1949. Contribution a l'étude des isopodes marins et fluviatiles du Congo. Annales du Musée du Congo Belge, Zoologie, Series 3, 1:77–208.

Bruce, N. L. 1980a. Cirolanidae (Crustacea: Isopoda) of Australia. Heron Island and the Capricorn Group. Bulletin of Marine Science 30:108–130.

———. 1980b. The Cirolanidae (Crustacea: Isopoda) of Australia: The Coral Sea. Cahiers de l'Indo-Pacifique 2:155–173.

———. 1981a. Cirolanidae (Crustacea: Isopoda) of Australia: Diagnoses of *Cirolana* Leach, *Metacirolana* Nierstrasz, *Neocirolana* Hale, *Anopsilana* Paulian and Deboutteville, and three new genera—*Natatolana*, *Politolana* and *Cartetolana*. Australian Journal of Marine and Freshwater Research 32:945–966.

———. 1981b. The Cirolanidae (Crustacea: Isopoda) of Australia: New species and a new genus from southeastern Australia. Records of the Australian Museum 33:644–672.

———. 1981c. Redescription of the isopod (Crustacea) family Phoratopodidae. Beaufortia 31(5):107–110.

———. 1985. *Calyptolana hancocki*, a new genus and species of marine isopod (Cirolanidae) from Aruba, Netherlands Antilles, with a synopsis of Cirolanidae known from the Caribbean and the Gulf of Mexico. Journal of Crustacean Biology 5:707–716.

———. 1986a. Cirolanidae (Crustacea: Isopoda) of Australia. Records of the Australian Museum, Supplement 6:1–239.

———. 1986b. New records of isopod crustaceans from Hong Kong. Pp. 549–554 *in* B. Morton (ed.), Proceedings of the Second International Marine Biological Workshop. Hong Kong Univ. Press, Hong Kong.

———. 1991. New records of marine isopod crustaceans (Sphaeromatidae, Cirolanidae) from south-eastern Australia. Memoirs of the Museum of Victoria 52:263–275.

———. 1992. *Anopsilana barnardi*, a new species of estuarine cirolanid crustacean isopod from tropical eastern Australia. Memoirs of the Queensland Museum 32:1–8.

———, and T. E. Bowman. 1982. The status of *Cirolana parva* Hansen, 1890 (Crustacea, Isopoda, Cirolanidae), with notes on its distribution. Proceedings of the Biological Society of Washington 95:325–333.

———, R. C. Brusca, and P. M. Delaney. 1982. The status of the isopod families Corallanidae Hansen, 1890, and Excorallanidae Stebbing, 1904 (Flabellifera). Journal of Crustacean Biology 2:464–468.

———, and J. Ellis. 1983. *Cirolana cranchi* Leach, 1818 (Crustacea: Isopoda: Cirolanidae) redescribed, with notes on its distribution. Bulletin of the British Museum (Natural History), Zoology 44:75–84.

———, and W. Javed. 1987. A new genus and two new species of cirolanid isopod Crustacea from the northern Indian Ocean. Journal of Natural History 21:1451–1460.

———, and D. A. Jones. 1978. The systematics of some Red Sea Isopoda (Family Cirolanidae) with descriptions of two new species. Journal of Zoology, London 185:395–413.

———, and ———. 1981. The systematics and ecology of some cirolanid isopods from southern Japan. Journal of Natural History 15:67–85.

Brusca, R. C. 1977. Range extension and new host records of cymothoid isopods (Isopoda: Cymothoidae) in the east Pacific. Bulletin of the Southern California Academy of Sciences 76:128–131.

———. 1978a. Studies on the cymothoid fish symbionts of the eastern Pacific (Isopoda: Cymothoidae). I. Biology of *Nerocila californica*. Crustaceana 34:141–154.

———. 1978b. Studies on the cymothoid fish symbionts of the eastern Pacific (Crustacea: Isopoda: Cymothoidae). II. Biology and systematics of *Lironeca vulgaris*. Occasional Papers of the Allan Hancock Foundation (new series) 2:1–19.

———. 1980. Common Intertidal Invertebrates of the Gulf of California. 2nd edition. Univ. of Arizona Press, Tucson.

———. 1981. A monograph on the Isopoda Cymothoidae (Crustacea) of the eastern Pacific. Zoological Journal of the Linnean Society 73:117–199.

———. 1983a. Two new idoteid isopods from Baja California and the Gulf of California (Mexico) and analysis of the evolutionary history of the genus *Colidotea* (Crustacea: Isopoda: Idoteidae). Transactions of the San Diego Society of Natural History 20:69–79.

———. 1983b. A monograph on the isopod family Aegidae in the tropical eastern Pacific. I. The genus *Aega*. Allan Hancock Foundations Monographs in Marine Biology 12:1–39.

———. 1984. Phylogeny, evolution and biogeography of the marine isopod subfamily Idoteinae (Crustacea: Isopoda: Idoteidae). Transactions of the San Diego Society of Natural History 20:99–134.

———. 1987. Biogeographic relationships of Galapagos marine isopod crustaceans. Bulletin of Marine Science 41:268–281.

———, and S. France. 1992. A monograph on the isopod family Aegidae in the tropical eastern Pacific. II. The genus *Rocinela*. Zoological Journal of the Linnean Society 106:231–275.

———, and M. R. Gilligan. 1983. Tongue replacement in a marine fish (*Lutjanus guttatus*) by a parasitic isopod (Crustacea: Isopoda). Copeia 3:813–816.

———, and E. W. Iverson. 1985. A guide to the marine isopod Crustacea of Pacific Costa Rica. Revista de Biología Tropical 33, Supplement 1:1–77.

———, and M. Ninos. 1978. The status of *Cirolana californiensis* Schultz, and *C. deminuta* Menzies and George, with a key to the Californian species of *Cirolana* (Isopoda: Cirolanidae). Proceedings of the Biological Society of Washington 91:379–385.

———, and B. R. Wallerstein. 1977. The marine isopod crustaceans of the Gulf of California. I. Family Idoteidae. American Museum Novitates 2634:1–17.

———, and ———. 1979a. Zoogeographic patterns of idoteid isopods in the northeast Pacific, with a review of shallow-water zoogeography for the region. Bulletin of the Biological Society of Washington 3:67–105.

———, and ———. 1979b. The marine isopod crustaceans of the Gulf of California. II. Idoteidae. New genus, new species, new records, and comments on the morphology, taxonomy and evolution within the family. Proceedings of the Biological Society of Washington 92:253–271.

———, and J. R. Weinberg. 1987. A new isopod crustacean from Pacific Panama, *Excirolana chamensis* new species (Isopoda: Flabellifera: Cirolanidae). Natural History Museum of Los Angeles County, Contributions in Science 392:11–17.

———, and G. D. F. Wilson. 1991. A phylogenetic analysis of the Isopoda with some classificatory recommendations. Memoirs of the Queensland Museum 31:143–204.

Calman, W. T. 1898. On a collection of Crustacea from Puget Sound. Annals of the New York Academy of Science 11:259–292.

———. 1909. Crustacea. Fascicle 3, Pp. 1–346 *in* R. Lankester (ed.), A Treatise on Zoology, Part VII. Adam and Charles Black, London.

Carvacho, A. 1977. Isopodes intertidaux des côtes du centre et du nord du Chili. 1. Familles des Cirolanidae, Excorallanidae et Corallanidae. Crustaceana 32:27–44.

———, and Y. Haasmann. 1984. Isópodos litorales de Oaxaca, Pacífico mexicano. Cahiers de Biologie Marine 25:15–32.

Chin, E. 1972. Southeast Pacific expedition on the R/V *Anton Bruun*, general account, station list, and hydrographic data. *Anton Bruun* Reports, Scientific Results of the Southeast Pacific Expedition 1:1–86. Texas A&M University, College Station, Texas.

Cole, G. A., and Minckley, W. L. 1966. *Speocirolana thermydronis*, a new species of cirolanid isopod crustacean from central Coahuila, México. Tulane Studies in Zoology 13:17–22.

Croizat, L., G. Nelson, and D. E. Rosen. 1974. Centers of origin and related concepts. Systematic Zoology 23:265–287.

Czerniavsky, V. 1868. Materialia ad zoographium Ponticam comparatam. [Transactions of the Russian Naturalists Society in St. Petersburg] 1:19–136 (in Russian).

Dana, J. D. 1852. On the classification of the Crustacea Choristopoda or Tetradecapoda. American Journal of Science and Arts, 2nd series 14(41):297–316.

———. 1853. Crustacea, Part II. Pp. 689–1618 *in* United States Exploring Expedition during the Years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U.S.N., Vol. 14. C. Sherman, Philadelphia.

Day, F. 1884. Exhibition of, and remarks upon, a specimen of a dog-fish (*Acanthias vulgaris*) internally devoured by parasites. Proceedings of the Zoological Society of London, 3rd Series, p. 44.

Degrave, S., and D. A. Jones. 1991. *Eurydice mauritanica* new species (Isopoda, Flabellifera, Cirolanidae) from western Africa, with distribution and list of species of Cirolanidae known from the region. Journal of Crustacean Biology 11:150–155.

Delaney, P. M. 1982. The synonymy of *Excorallana kathyae* Menzies, 1962, with *Excorallana truncata* (Richardson, 1899), with a redescription of the species (Crustacea, Isopoda, Excorallanidae). Journal of Crustacean Biology 2:273–280.

———. 1984. Isopods of the genus *Excorallana* Stebbing, 1904, from the Gulf of California, Mexico (Crustacea, Isopoda Corallanidae). Bulletin of Marine Science 34:1–120.

———. 1986. The synonymy of *Cirolana tuberculata* (Richardson, 1910) (Isopoda: Flabellifera: Cirolanidae). Proceedings of the Biological Society of Washington 99:731–734.

———. 1989. Phylogeny and biogeography of the marine isopod family Corallanidae (Crustacea, Isopoda, Flabellifera). Natural History Museum of Los Angeles County, Contributions in Science 409:1–75.

———, and R. C. Brusca. 1985. Two new species of *Tridentella* Richardson, 1905 (Isopoda: Flabellifera: Tridentellidae) from California, with a rediagnosis and comments on the family and a key to the genera of Tridentellidae and Corallanidae. Journal of Crustacean Biology 5:728–742.

DeRuyck, A. M. C., A. McLachlan, and T. E. Donn, Jr. 1991. The activity of three intertidal sand beach isopods (Flabellifera: Cirolanidae). Journal of Experimental Marine Biology and Ecology 146:163–180.

Desmarest, A. G. 1825. Considérations générales sur la classe des Crustacés. Isopodes, pp. 281–327. Paris.

Dexter, D. M. 1972. Comparison of the community structures in a Pacific and Atlantic Panamanian sandy beach. Bulletin of Marine Science 22:449–462.

———. 1974. Sandy-beach fauna of the Pacific and Atlantic coasts of Costa Rica and Colombia. Revista de Biología Tropical 22:51–66.

———. 1976. The sand-beach fauna of Mexico. Southwestern Naturalist 20:479–485.

———. 1979. Community structure and seasonal variation in intertidal Panamanian sandy beaches. Estuarine and Coastal Marine Science 9:543–558.

Eleftheriou, A., and D. A. Jones. 1976. The genus *Eurydice* on the west coast of India. Journal of Zoology, London 178:385–394.

Fish, J. D., and S. Fish. 1972. The swimming rhythm of *Eurydice pulchra* and a possible explanation of intertidal migration. Journal of Experimental Marine Biology and Ecology 8:195–200.

Fish, S. 1970. The biology of *Eurydice pulchra* (Crustacea: Isopoda). Journal of the Marine Biological Association of the United Kingdom 50:753–768.

Glynn, P. W., D. M. Dexter, and T. E. Bowman. 1975. *Excirolana braziliensis*, a Pan-Amerian sand beach isopod: taxonomic status, zonation and distribution. Journal of Zoology, London 175:509–521.

González-Liboy, J. A. 1971. The zonation and distribution of marine beach macro-invertebrates at Playa Maní, Mayagüez, Puerto Rico. M.S. thesis, University of Puerto Rico, Mayagüez.

Gurjanova, E. 1933. Die marinen Isopoden der Arktis. Pp. 390–470 *in* Romer and Schaudinn (ed.), Fauna Arktica, Vol. 6. Gustav Fisher, Jena, Germany.

Hale, H. M. 1925. Review of Australian isopods of the cymothoid group. Part 1. Transactions of the Royal Society of South Australia 49:128–185.

———. 1933. Tanaidacea and Isopoda collected by the Great Barrier Reef Expedition. Annals and Magazine of Natural History, Series 10:557–561.

Hansen, H. J. 1890. Cirolanidae et familiae nonnulae propinquae Musaei Hauniensis. Det Kongelige Danske Videnskabernes Selskab Skrifter, Naturvidenskabelig og Mathematissk 6:237–426.

———. 1903. The deep-sea isopod *Anuropus branchiatus*, Beddard, and some remarks on *Bathynomus giganteus*, A. Milne Edwards. Zoological Journal of the Linnean Society 29:12–25.

———. 1905. Revision of the European marine forms of the Cirolaninae, a subfamily of Crustacea Isopoda. Zoological Journal of the Linnean Society 29:337–373.

———. 1916. Danish Ingolf-Expedition, Vol. III, Part 5. Crustacea Malacostraca. H. Hagerup, Copenhagen.

Hastings, M. H. 1981. Semi-lunar variations of endogenous circa-tidal rhythms of activity and respiration in the isopod *Eurydice pulchra*. Marine Ecology Progress Series 4:85–90.

———, and E. Naylor. 1980. Ontogeny of an endogenous rhythm in *Eurydice pulchra*. Journal of Experimental Marine Biology and Ecology 46:137–145.

Haswell, W. A. 1882. Catalogue of the Australian Stalk- and Sessile-Eyed Crustacea. The Australian Museum, Sydney.

Hewatt, W. G. 1937. Ecological studies on selected marine intertidal communities of Monterey Bay, California. American Midland Naturalist 18:161–206.

Holdich, D. M. 1981. Opportunistic feeding behaviour in a predatory isopod. Crustaceana 41:101–103.

———, K. Harrison, and N. L. Bruce. 1981. Cirolanid isopod crustaceans from the Townsville region of Queensland, Australia, with descriptions of six new species. Journal of Natural History 15:555–605.

Holmes, S. J. 1904. On some new or imperfectly known species of west American Crustacea. Proceedings of the California Academy of Sciences 3:307–324.

Ives, J. E. 1891. Crustacea from the northern coast of Yucatan, the harbor of Vera Cruz, the west coast of Florida, and the Bermuda Islands. Proceedings of the Academy of Natural Sciences of Philadelphia 43:176–200.

Jansen, K. P. 1981. *Eurylana*, a new genus of Cirolanidae (Isopoda: Flabellifera) with two species, *Eurylana cookii* (Filhol) and *Eurylana arcuata* (Hale). Journal of the Royal Society of New Zealand 11:5–10.

Johnson, W. S. 1974. Population dynamics, energetics and biology of the marine isopod *Cirolana harfordi* (Lockington) in Monterey Bay, California. Ph.D. dissertation, Stanford University, Stanford, California.

———. 1976a. Biology and population dynamics of the intertidal isopod *Cirolana harfordi*. Marine Biology 36:343–350.

———. 1976b. Population energetics of the intertidal isopod *Cirolana harfordi*. Marine Biology 36:351–357.

Jones, D. A. 1968. The functional morphology of the digestive system in the carnivorous intertidal isopod *Eurydice*. Journal of Zoology, London 156:363–376.

———. 1970a. Population densities and breeding in *Eurydice pulchra* Leach and *Eurydice affinis* Hansen in Britain. Journal of the Marine Biological Association of the United Kingdom 50:635–655.

———. 1970b. Factors affecting the distribution of the intertidal isopods *Eurydice pulchra* Leach and *E. affinis* Hansen in Britain. Journal of Animal Ecology 39:455–472.

———. 1971. The systematics and ecology of some sand beach isopods (Crustacea: Eurydicidae) from the coast of Kenya. Journal of Zoology, London 165:201–227.

———. 1974. The systematics and ecology of some sand beach isopods (Family Cirolanidae) from the coasts of Saudi Arabia. Crustaceana 26:201–211.

———. 1976. The systematics and ecology of some isopods of the genus *Cirolana* (Cirolanidae) from the Indian Ocean region. Journal of Zoology, London 178:209–222.

———: 1983. On the status of the cirolanid isopod genera *Annina*

Budde-Lund, 1908, and *Excirolana* Richardson, 1912. Crustaceana 45:309–312.

———, and J. D. Icely. 1981. *Excirolana bowmani*, a new mangrove-boring isopod from Kenya (Isopoda, Cirolanidae). Crustaceana 40:266–271.

———, and E. Naylor. 1967. The distribution of *Eurydice* (Crustacea: Isopoda) in British waters, including *E. affinis* new to Britain. Journal of the Marine Biological Association of the United Kingdom 47:373–382.

———, and ———. 1970. The swimming rhythm of the sand beach isopod *Eurydice pulchra*. Journal of Experimental Marine Biology and Ecology 4:188–199.

Kensley, B. 1977. New records of marine Crustacea Isopoda from South Africa. Annals of the South African Museum 72:261–323.

———. 1978. Guide to the Marine Isopods of Southern Africa. South African Museum, Cape Town, South Africa.

———. 1984. The South African Museum's *Meiring Naude* cruises. Part 15. Marine Isopoda of the 1977, 1978, 1979 cruises. Annals of the South African Museum 93:213–301.

———. 1987. Further records of marine isopod crustaceans from the Caribbean. Proceedings of the Biological Society of Washington 100:559–577.

———. 1989. Marine isopod crustaceans from the St. Paul and Amsterdam Islands, southern Indian Ocean. Bulletin du Muséum national d'Histoire naturelle, Series 11 (1):147–164.

———, and M. Schotte. 1987. New records of isopod Crustacea from the Caribbean, the Florida Keys and the Bahamas. Proceedings of the Biological Society of Washington 100:216–247.

———, and ———. 1989. Guide to the Marine Isopod Crustaceans of the Caribbean. Smithsonian Institution Press, Washington, D.C.

Knight-Jones, E. W., and S. Z. Qasim. 1967. Responses of Crustacea to changes in hydrostatic pressure. Proceedings of a Symposium on Crustacea, Journal of the Marine Biological Association, India 3:1132–1150.

Kussakin, O. G. 1979. Marine and Brackish-Water Isopoda of Cold and Temperate (Boreal) Waters of the Northern Hemisphere. Part 1. (Flabellifera, Valvifera, and Tyloidea). National Academy of Sciences, U.S.S.R., Leningrad, pp. 1–470 (in Russian).

Leach, W. E. 1815. A tabular view of the external characters of four classes of animals which Linné arranged under Insecta; with the distribution of the genera composing three of these classes into orders, etc. and descriptions of several new genera and species. Transactions of the Linnean Society of London 11: 306–400.

———. 1818. Cymothoadées. Pp 338–354 *in* F. Cuvier (ed.). Dictionnaire des sciences naturelles, Vol. 12. Paris and Strasbourg.

Lemos de Castro, A., and I. N. da Silva Brum. 1969. Sôbre as espécies de *Excirolana* Richardson do litoral Atlântico das Américas (Isopoda, Cirolanidae). Boletim do Museu Nacional, Nova serie, Zoologia 271:1–21.

Lockington, W. N. 1877. Description of seventeen new species of Crustacea. Proceedings of the California Academy of Sciences 7:41–48.

Menzies, R. J. 1962a. The zoogeography, ecology and systematics of the Chilean marine isopods. The Lund University Chile Expedition, 1948–1949, No. 42. Lund Universitets Ärskriffter 2(57):1–162.

———. 1962b. The marine isopod fauna of Bahia de San Quintín, Baja California, Mexico. Pacific Naturalist 3:338–348.

———, and J. L. Barnard. 1959. Marine Isopoda on coastal shelf bottoms of southern California: Systematics and ecology. Pacific Naturalist 1:3–35.

———, and D. Frankenberg. 1966. Handbook on the Common Marine Isopod Crustacea of Georgia. Univ. of Georgia Press, Athens, Georgia.

———, and R. Y. George. 1972. Isopoda of the Peru–Chile Trench. Anton Bruun Reports, Scientific Results of the Southeast Pacific Expedition 9:1–124. Texas A & M Univ. Press, College Station, Texas.

———, and P. W. Glynn. 1968. The common marine isopod Crustacea of Puerto Rico. A handbook for marine biologists. Studies on the Fauna of Curaçao and Other Caribbean Islands 27:1–133.

———, and W. L. Kruczynski. 1983. Isopoda, Crustacea (exclusive of Epicaridea). Memoirs of the *Hourglass* Cruises 6:1–126. Florida Department of Natural Resources, St. Petersburg, Florida.

Messana, G. 1984. A new locality for *Annina lacustris* Budde-Lund, 1908. Some consideration on taxonomy and reproduction of the genera *Annina* and *Excirolana* (Isopoda, Cirolanidae). Revue Zoologique Africaine 98:766–770.

Miers, E. J. 1876. Catalogue of the stalk and sessile-eyed Crustacea of New Zealand. Colonial Museum and Geological Department of New Zealand, Natural History Publication 10:1–136.

Miller, M. A. 1968. Isopoda and Tanaidacea from buoys in coastal waters on the continental United States, Hawaii, and the Bahamas (Crustacea). Proceedings of the United States National Museum 125 (3652):1–53.

———, 1975. Phylum Arthropoda. Crustacea, Tanaidacea and Isopoda. Pp. 227–312 *in* R. Y. Smith and J. T. Carlton (eds.). Light's Manual: Intertidal Invertebrates of the Central Californian Coast. Univ. of California Press, Berkeley.

Milne Edwards, A. 1840. Histoire Naturelle des Crustacés. Vol 3. Roret, Paris.

———, and Bouvier, E. L. 1902. Reports on the results of dredging under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877–1878), in the Caribbean Sea (1878–1879), and along the Atlantic coast of the United States (1880), by the U.S. Coast Survey Steamer "Blake." XL. Les Bathynomes. Memoirs of the Museum of Comparative Zoology, Harvard 27:133–174.

Monod, T. 1930. Contribution a l'étude des "Cirolanidae." Annales des Sciences Naturelle, Zoologie, 10 series 13:129–183.

———. 1931. Sur quelques crustacés aquatiques d'Afrique (Cameroun et Congo). Revue de Zoologie et de Botanique Africaine 21:1–36.

———. 1933. Mission Robert-Ph. Dollfus en Egypte. Tanaidacea et Isopoda. Mémoires de l'Institut d'Egypte, Cairo 21:161–264.

———. 1976. Remarques sur quelques Cirolanidés (Crustacés, Isopodes). Bulletin du Muséum d'Histoire Naturelle, Series 3, 358 (Zool. 251):133–161.

Montagu, G. 1804. Description of several marine animals found on the south coast of Devonshire. Transactions of the Linnean Society of London, 7:61–85.

Moore, H. F. 1902. Report on Porto Rican Isopoda. United States Fish Commission Bulletin for 1900, 2:161–176.

Moreira, P. S. 1972. Species of *Eurydice* from southern Brazil. Boletim do Instituto Oceanografico, São Paulo 21:69–91.

Morris, R. H., D. P. Abbott, and E. C. Haderlie. 1980. Intertidal Invertebrates of California. Stanford Univ. Press, Stanford, California.

Müller, H.-G. 1991. Description of *Metacirolana agujae* n. sp., and redescription of *M. agaricicola* Kensley, 1984, from the Caribbean Sea of Colombia (Isopoda: Cirolanidae). Bijdragen tot de Dierkunde 61:17–30.

Naylor, E. 1957. Isopoda. Suborder Flabellifera. Fiches d'Identification du Zooplancton, Zooplankton Sheet 78:1–4.

———. 1972. British Marine Isopods. Synopses of the British Fauna No. 3. Academic Press, London.

Nierstrasz, H. F. 1931. Die Isopoden der Siboga-Expedition III. Isopoda Genuina. 2. Flabellifera. Siboga-Expeditie Monographs 32c:123–233.

———, and J. H. Schuurmans Stekhoven, Jr. 1930. Isopoda Genuina. Pp. 57–133 *in* Tierwelt der Nord- und Ostsee, Vol. 10, Crustacea. Grimpe and Wagler, Leipzig, Germany.

Nordenstam, A. 1946. Marine Isopoda from Professor Dr. Sixten Bock's Pacific Expedition 1917–1918. Arkiv för Zoologi, Stockholm 37(A):1–31.

Norman, A. M., and T. Scott. 1906. The Crustacea of Devon and Cornwall. W. Wesley and Sons, London.

Notenboom, J. 1981. Amsterdam Expeditions to the West Indian Islands, Report 12. Some new hypogean cirolanid isopod crustaceans from Haiti and Mayaguana (The Bahamas). Bijdragen tot de Dierkunde 51:313-331.

Nunomura, N. 1981. Isopod crustaceans from Sado Island in the Sea of Japan. Annual Report of the Sado Marine Biological Station, Niigata University 11:43–62.

———. 1982. *Cirolana toyomaensis*, a new cirolanid isopod from Toyama Bay, central Japan. Bulletin of the Toyama Science Museum 4:23–30.

———. 1985a. Marine isopod crustaceans on the coast of Toyama Bay. Memoirs of the National Science Museum, Tokyo, 18:121–139.

Packard, A. S. 1900. A new eyeless isopod crustacean from Mexico. Proceedings of the American Association for the Advancement of Science 49:228.

Paul, A. Z., and R. J. Menzies. 1971. Sub-tidal isopods of the Fosa de Cariaco, Venezuela, with descriptions of two new genera and twelve new species. Boletin del Instituto Oceanográfico, Universidad de Oriente 10:29–48.

Paulian, R., and C. D. Debouteville. 1956. Un cirolanidé cavernicole à Madagascar (Isopode). Mémoires de l'Institut Scientifique de Madagascar, Series A, 11:85–88.

Perry, D. M. 1988. Effects of associated fauna on growth and productivity in the red mangrove. Ecology 69:1064–1075.

———, and R. C. Brusca. 1989. Effects of the root-boring isopod *Sphaeroma peruvianum* on red mangrove forests. Marine Ecology Progress Series 57:287–292.

Racovitza, E. G. 1912. Biospeologica, 27. Cirolanidés (premier série). Archives de Zoologie Experimentale et Générale, 5^e^ série, 10(5):203–329.

Richardson, H. R. 1899a. Key to the isopods of the Pacific coast of North America, with descriptions of twenty-two new species. Proceedings of the United States National Museum 21:815–869.

———. 1899b. Key to the isopods of the Pacific coast of North America, with descriptions of twenty-two new species. Annals and Magazine of Natural History 7(4):157–187; 260–277; 321–338.

———. 1900. Synopses of North American invertebrates. VII. The Isopoda. American Naturalist 34:207–230; 295–309.

———. 1901. Keys to the isopods of the Atlantic coast of North America, with descriptions of new and little-known species. Proceedings of the United States National Museum 23:493–579.

———. 1904a. Contribution to the natural history of the Isopoda. I. Isopoda collected in Japan in the year 1900 by the U.S. Fish Commission steamer *Albatross* and in the year 1881 by the U.S.S. *Palos*. Proceedings of the United States National Museum 27:1–89.

———. 1904b. Contributions to the natural history of the Isopoda. V. Isopod crustaceans of the northwest coast of North America. Proceedings of the United States National Museum 27:657–681.

———. 1905. A monograph on the isopods of North America. Bulletin of the United States National Museum 54:1–727.

———. 1912a. Marine and terrestrial isopods from Jamaica. Proceedings of the United States National Museum 42(1894):187–194.

———. 1912b. Descriptions of a new genus of isopod crustaceans, and of two new species from South America. Proceedings of the United States National Museum 43:201–204.

Ricketts, E. F., J. Calvin, and J. W. Hedgpeth (rev. D. W. Phillips). 1985. Between Pacific Tides. Stanford Univ. Press, Stanford, California.

Rioja, E. 1956. Estudios carcinológicos 35. Datos sobre algunos isópodos cavernícolas de la isla de Cuba. Anales del Instituto de Biología, Universidad Nacional Autónoma de México 27:437–462.

Rosen, D. E. 1975. A vicariance model of Caribbean biogeography. Systematic Zoology 24:431–464.

Salvat, B. 1966. *Eurydice pulchra* (Leach, 1815), *Eurydice affinis* (Hansen, 1905) (Isopodes, Cirolanidae)—taxonomie, éthologie, écologie, répartition verticale, et cycle reproducteur. Acta Société Linnéenne de Bordeaux 103A:1–77.

Sars, G. O. 1897. An Account of the Crustacea of Norway with Short Descriptions and Figures of All the Species. Vol. 2. Isopoda, Part III, IV. Anthuridae, Gnathiidae, Aegidae, Cirolanidae, Limnoriidae. Bergen Museum, Bergen, Norway.

Schotte, M., R. W. Heard, and B. Kensley. 1991. Studies on the Crustacea of the Turks and Caicos Islands, British West Indies. III. Records of marine Isopoda from Pine Cay, Fort George Cay, Water Cay, and adjacent waters. Gulf Research Reports 8(3): 251–257.

Schultz, G. A. 1966. Submarine canyons of southern California. Part 4. Systematics: Isopoda. Allan Hancock Pacific Expeditions 27:1–56.

———. 1969. How to Know the Marine Isopod Crustaceans. Wm. C. Brown Co., Dubuque. 359 pp.

Schuster, O. 1954. Zwei neue Crustaceen von der pazifischen Küste Mittel-Amerikas (Amphipoda und Isopoda). Senckenbergiana Biologica 35:103–105.

Singarajah, K. V. 1966. Some aspects of the behaviour of planktonic animals. Ph.D. dissertation, Univ. of Wales, Cardiff. 91 pp.

Soika, G. A. 1955. Ethologie, écologie, systématique et biogeographie des *Eurydice* s. str. Vie et Milieu 6(1):38–52.

Stafford, B. E. 1912. Studies in Laguna Beach Isopoda. Laguna Marine Laboratory, Annual Report 1:118–133.

Stebbing, T. R. R. 1893. A History of Crustacea. Recent Malacostraca. International Scientific Series LXXIV. Kegan, Paul and Trench, London, England.

———. 1902. South African Crustacea. Part 2. Marine Investigations in South Africa 2:1–92.

———. 1904a. Gregarious Crustacea from Ceylon. Spolia Zeylanica 2:1–26.

———. 1904b. Marine Crustaceans. XII. Isopoda, with description of a new genus. Pp. 699–721 *in* J. S. Gardiner (ed.). Fauna and Geography of the Maldive and Laccadive Archipelagoes, Vol. 2(10). University Press, Cambridge, England.

———. 1905. Report on the Isopoda collected by Professor Herdman at Ceylon in 1902. Pp. 1–64 *in* W. A. Herdman (ed.). Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar, Vol. 4, Supplementary Report 23.

———. 1910a. No. VI. Isopoda from the Indian Ocean and British East Africa. The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of Mr. J. Stanley Gardiner. Vol. 1. Transactions of the Linnean Society of London, Zoology 14:83–122.

———. 1910b. Reports on the marine biology of the Sudanese Red Sea. XIV. On Crustacea Isopoda and Tanaidacea. Journal of the Linnean Society, Zoology 31:215–230.

Steinbeck, J., and E. F. Ricketts. 1941. Sea of Cortez. A Leisurely Journal of Travel and Research. Viking Press, New York, New York.

Stepien, C., and R. C. Brusca. 1985. Nocturnal attacks on nearshore fishes in southern California by crustacean zooplankton. Marine Ecology Progress Series 25:91–105.

Tattersall, W. M. 1906. The marine fauna of the coast of Ireland. Part V. Isopoda. Ireland Fisheries Scientific Investigations, 1904 II [published Jan., 1906]: 53–142.

———. 1911. Die nordischen Isopoden. Nordischen Plankton Abhandlungen 6:181–313.

———. 1921. Tanaidacea and Isopoda. British Antarctic *Terra-Nova* Expedition 1910. Zoology 3(8):191–258.

Thielemann, M. 1910. Beiträge zur Kenntnis der Isopodenfauna Ostasiens. Beiträge zur Naturgeschichte Ostasiens. Abhandlungen der Mathematisch-Physikalischen Klasse der Königlich Bayerische Akademie der Wissenschaft 2, Suppl. 3:1–110.

Thun, M., and R. C. Brusca. 1980. On the status of the eastern Pacific cymothoid fish parasite *Braga occidentalis* Boone, and its synonymy with *B. patagonica* Schioedte and Meinert (Crustacea: Isopoda: Cymothoidae). Bulletin of the California Academy of Sciences 79:130–132.

Tully, O., and P. O'Ceidigh. 1986. Density variations and population structure of *Eurydice inermis* and *E. truncata* (Isopoda, Cirolanidae) in the neuston of Galway Bay (Ireland). Cahiers de Biologie Marine 27:225–233.

Vanhöffen, E. 1914. Die Isopoden der Deutschen Südpolar-Expedition 1901–1903. Deutsche Südpolar-Expedition, Vol. 15, Zoology 7:449–598.

Van Name, W. G. 1936. The American land and freshwater isopod Crustacea. American Museum of Natural History Bulletin 71:1–535.

Wade, A. 1967. Studies on the biology of the West Indian clam, *Donax denticulatus* Linné. 1. Ecology. Bulletin of Marine Science 17:149–174.

Wägele, J.-W. 1983. On the homology of antennal articles in Isopoda. Crustaceana 45: 31-37.

Wägele, J.-W., and N. L. Bruce. 1989. *Natatolana pastorei* (Giambiagi, 1925) (Crustacea, Isopoda, Cirolanidae) from the Straits of Magellan, South America: Redescription and notes on functional morphology. Proceedings of the Biological Society of Washington 102:95–105.

Wallerstein, B. R., and R. C. Brusca. 1982. Fish predation: A preliminary study of its role in the zoogeography and evolution of shallow-water idoteid isopods (Crustacea: Isopoda: Idoteidae). Journal of Biogeography 9:135–150.

Weinberg, J. R., and V. R. Starczak. 1988. Morphological differences and low dispersal between local populations of the tropical beach isopod *Excirolana braziliensis*. Bulletin of Marine Science 42:296–309.

———, and ———. 1989. Morphological divergence of eastern Pacific and Caribbean isopods. Marine Biology 103:143–152.

Wetzer, R., P. M. Delaney, and R. C. Brusca. 1987. *Politolana wickstenae* new species, a new cirolanid isopod from the Gulf of Mexico, and a review of the "*Conilera* genus-group" of Bruce (1986). Natural History Museum of Los Angeles County, Contributions in Science 392:1–10.

Wilson, G. D. F. 1989. A systematic revision of the deep-sea subfamily Lipomerinae of the isopod crustacean family Munnopsidae. Bulletin of the Scripps Institution of Oceanography 27:1–138.

Woodring, W. P. 1957. Geology and paleontology of Canal Zone and adjoining ports of Panama. Geology and descriptions of Tertiary mollusks (Gastropods: Trochidae and Turritellidae). Geological Survey, Professional Paper 306A:1–145.

———. 1966. The Panama land bridge as a sea barrier. Proceedings of the American Philosophical Society 110:425–433.

Zuñiga, O., R. Peña, and M. Clarke. 1985. Historia de vida y producción de *Excirolana braziliensis* Richardson, 1912 (Isopoda: Cirolanidae). Estudios Oceanológicas 4:9–19.

Note added in proof. The following new generic names in the family Cirolanidae were published while this paper was in press: *Aatolana* Bruce, 1993; *Dodecalana* Carpenter, 1994; *Plakolana* Bruce, 1993; *Seychellana* Kensley and Schotte, 1994; *Zulialana* Botosaneanu and Viloria, 1993.